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Patent No. 6349291

NOTICE OF *INTER PARTES* REEXAMINATION

Notice is hereby given that a request for *inter partes* reexamination of U.S. Patent No. 6349291 was filed on 3-29-12 under 35 U.S.C. § 311 and 37 C.F.R. § 1.913.

The reexamination proceeding has been assigned Control No 95/001939

This Notice incorporates by reference into the patent file, all papers entered into the reexamination file.

Note: This Notice should be entered into the patent file.

US006349291B1

(12) **United States Patent**
Varma

(10) **Patent No.: US 6,349,291 B1**
(45) **Date of Patent: Feb. 19, 2002**

(54) **METHOD AND SYSTEM FOR ANALYSIS, DISPLAY AND DISSEMINATION OF FINANCIAL INFORMATION USING RESAMPLED STATISTICAL METHODS**

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(73) Assignee: **Attractor Holdings LLC**, Greenwich, CT (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/489,364**

(22) Filed: **Jan. 21, 2000**

(51) **Int. Cl.**[7] **G06F 17/60**

(52) **U.S. Cl.** **705/35**; 705/37

(58) **Field of Search** 705/35, 36, 37, 705/38

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(List continued on next page.)

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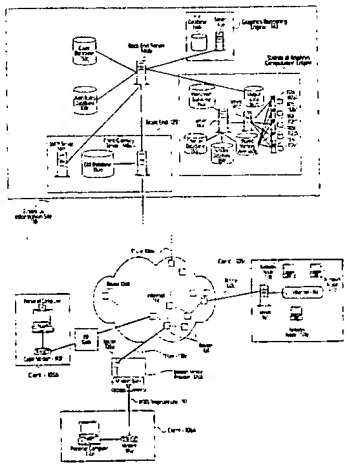
Assistant Examiner—Daniel S Felten
(74) *Attorney, Agent, or Firm*—Kenyon & Kenyon

(57) **ABSTRACT**

The present invention provides a method and system for the statistical analysis, display and dissemination of financial data over an information network such as the Internet and WWW. The present invention utilizes resampled statistical methods for the analysis of financial data. Resampled statistical analysis provides a meaningful and reasonable statistical description of financial information, which typically escapes modeling using parametric methods (i.e. assumptions of a Gaussian distribution). The present invention provides at least a GUI that provides functionality for user input of statistical queries, a statistical computation engine that performs statistical analysis of financial data and a graphical rendering engine that generates graphical display of statistical distributions generated by the statistical computation engine. According to one embodiment, the present invention employs a parallel processing architecture to speed generation of the resampled statistics.

31 Claims, 17 Drawing Sheets



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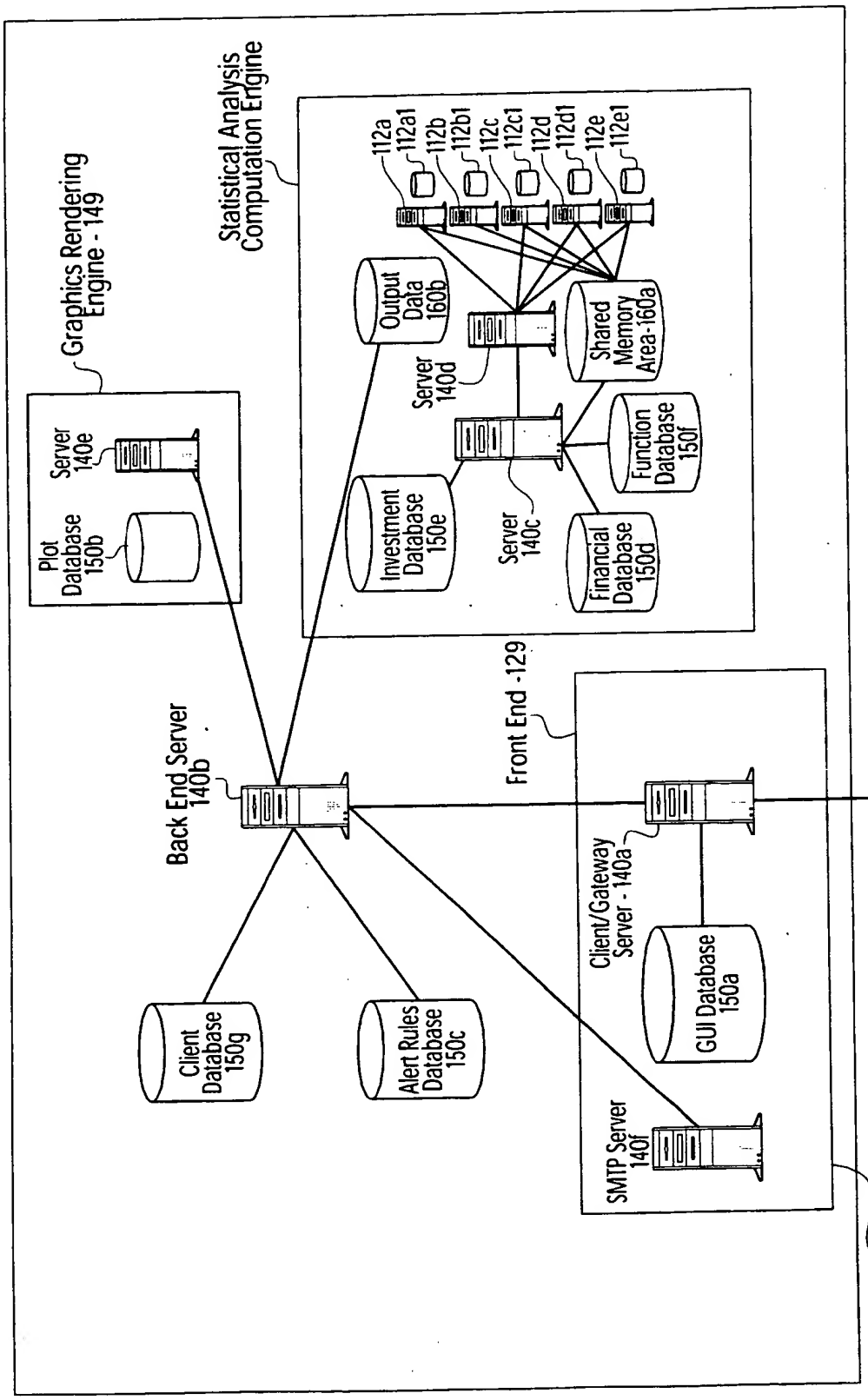
Graphics Rendering Engine - 149
Server 140e
Plot Database 150b
Statistical Analysis Computation Engine
112a
112a1
112b
112b1
112c
112c1
112d
112d1
112e
112e1
Output Data 160b
Server 140d
Shared Memory Area-160a
Function Database 150f
Investment Database 150e
Server 140c
Financial Database 150d
Back End Server 140b
Front End -129
Client/Gateway Server - 140a
GUI Database 150a
Client Database 150g
Alert Rules Database 150c
SMTP Server 140f
Financial Information Site 119
to FIG. 1(2)

FIG. 1(1)

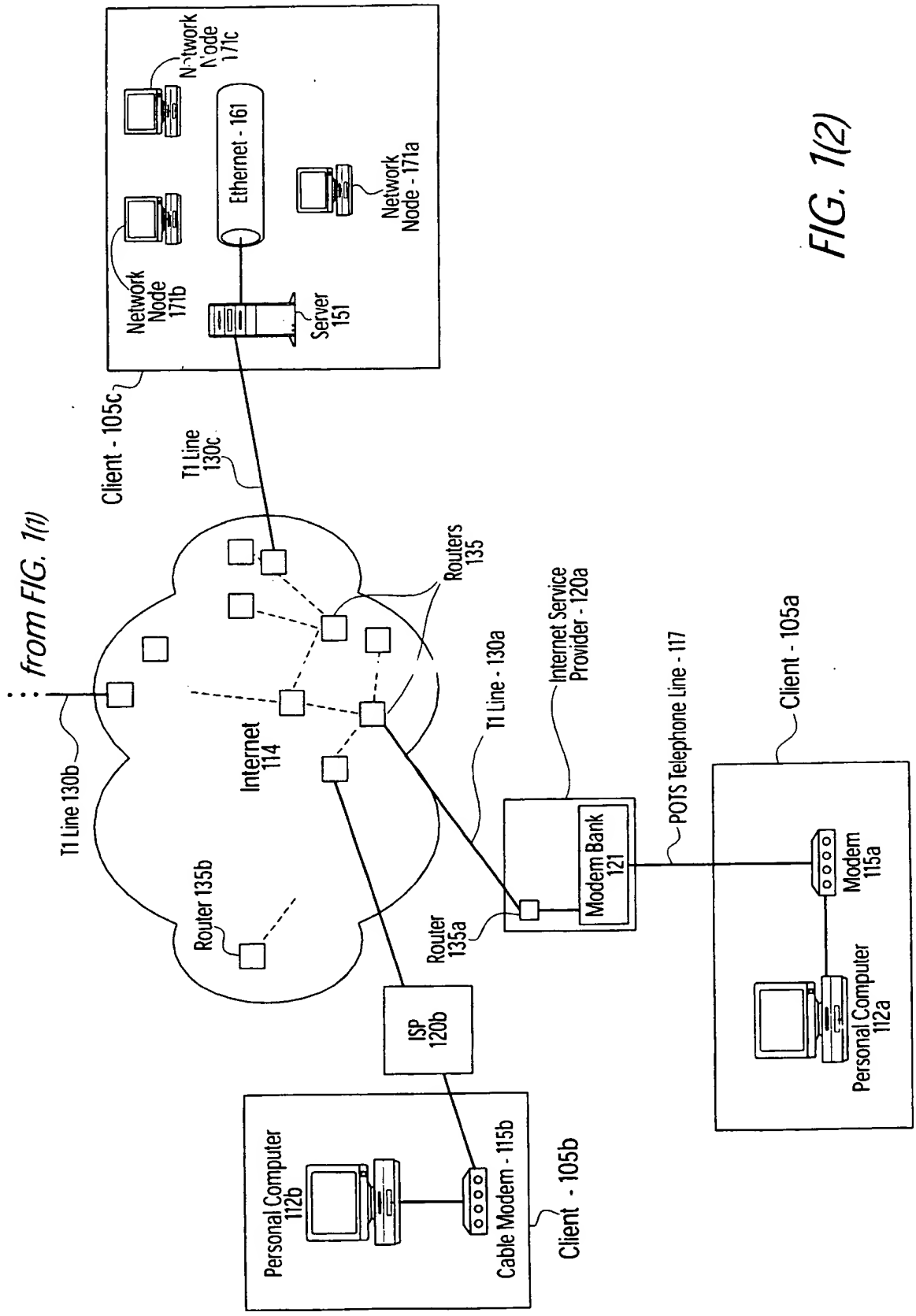
from FIG. 1(1)
T1 Line 130b
Internet 114
Router 135b
Routers 135
T1 Line 130c
Client - 105c
Network Node 171c
Ethernet - 161
Network Node - 171a
Network Node 171b
Server 151
Router 135a
T1 Line - 130a
Internet Service Provider - 120a
Modem Bank 121
POTS Telephone Line - 117
Client - 105a
Modem 115a
Personal Computer 112a
ISP 120b
Personal Computer 112b
Cable Modem - 115b
Client - 105b

FIG. 1(2)

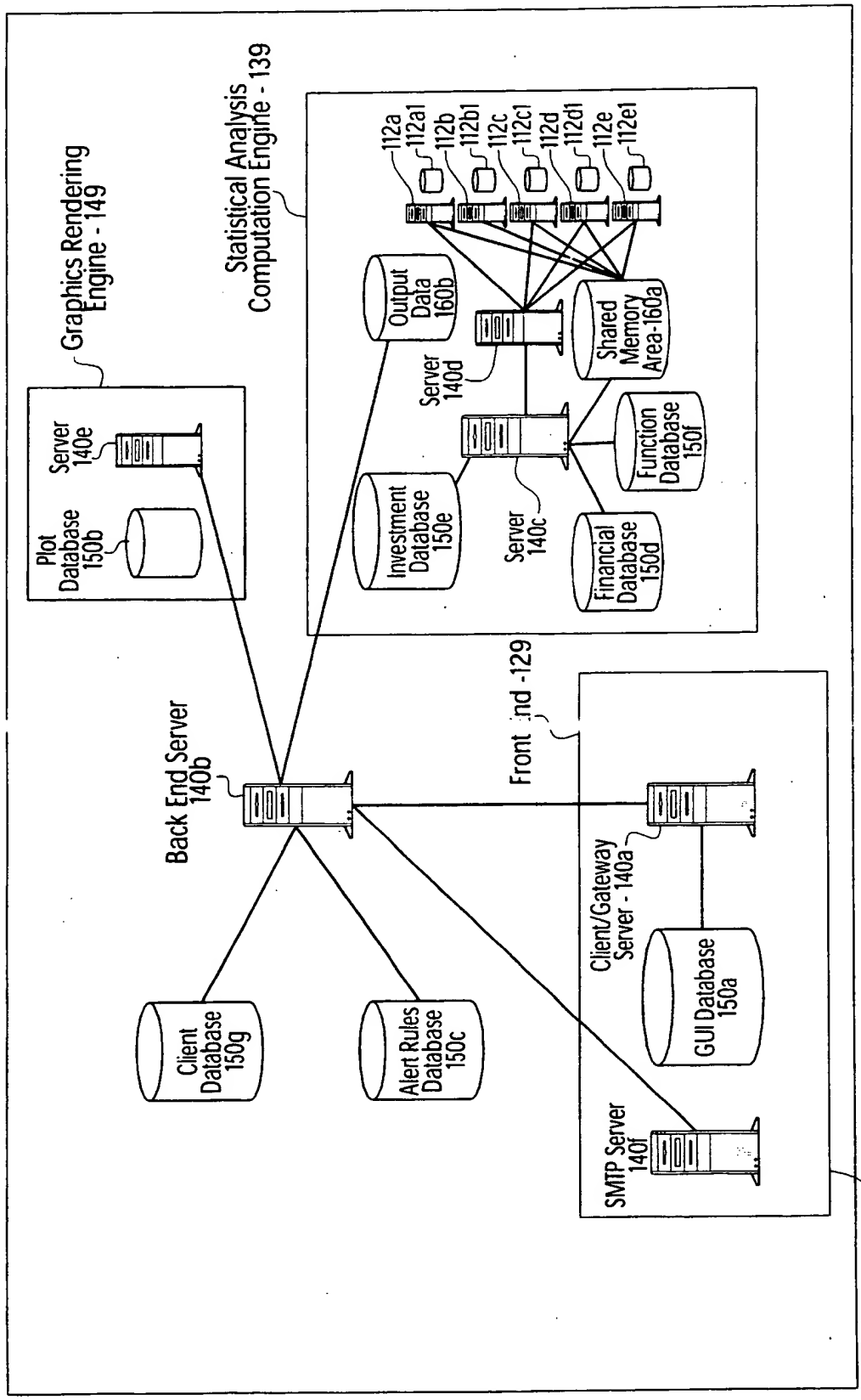
Financial Information Site 119
Graphics Rendering Engine - 149
Server 140e
Plot Database 150b
Statistical Analysis Computation Engine - 139
112a
112a1
112b
112b1
112c
112c1
112d
112d1
112e
112e1
Output Data 160b
Server 140d
Shared Memory Area-160a
Function Database 150f
Investment Database 150e
Server 140c
Financial Database 150d
Front End -129
Back End Server 140b
Client/Gateway Server - 140a
GUI Database 150a
Client Database 150g
Alert Rules Database 150c
SMTP Server 140f

FIG. 2

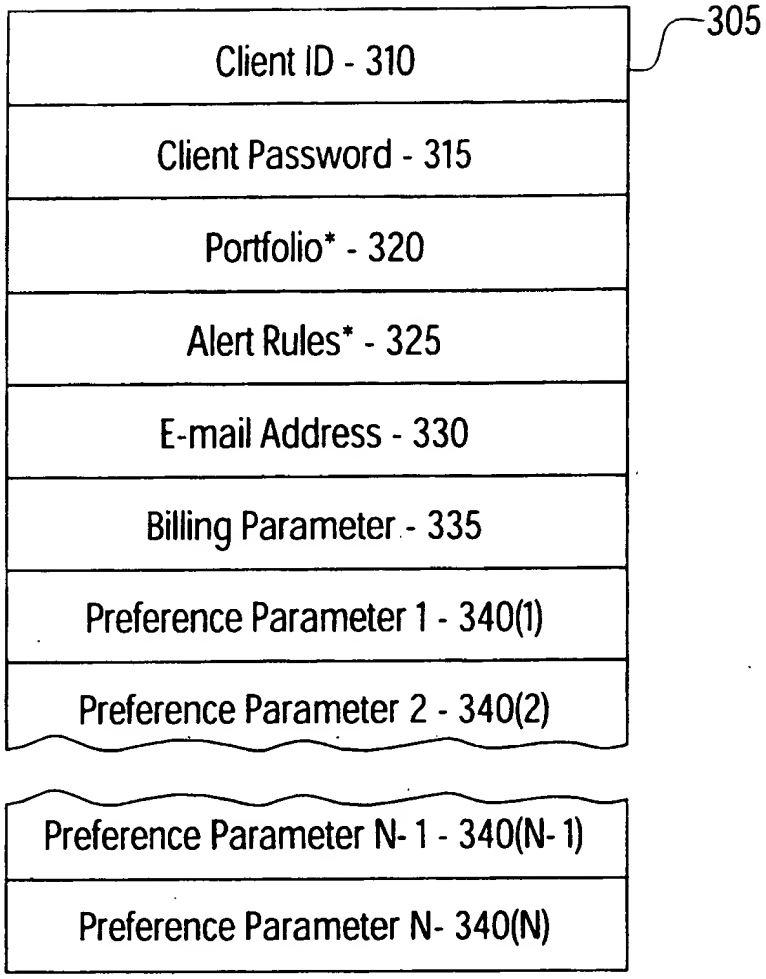
305
Client ID - 310
Client Password - 315
Portfolio* - 320
Alert Rules* - 325
E-mail Address - 330
Billing Parameter - 335
Preference Parameter 1 - 340(1)
Preference Parameter 2 - 340(2)
Preference Parameter N-1 - 340(N-1)
Preference Parameter N- 340(N)

FIG. 3

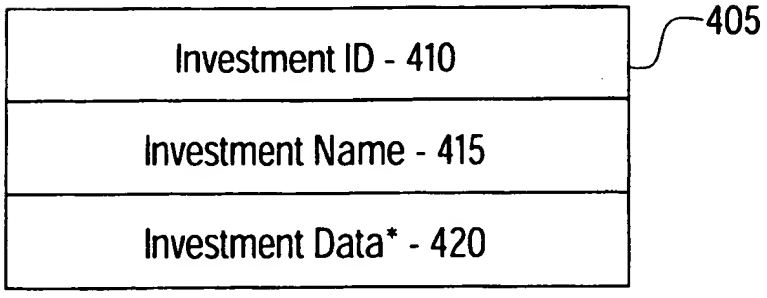
405
Investment ID - 410
Investment Name - 415
Investment Data* - 420

FIG. 4

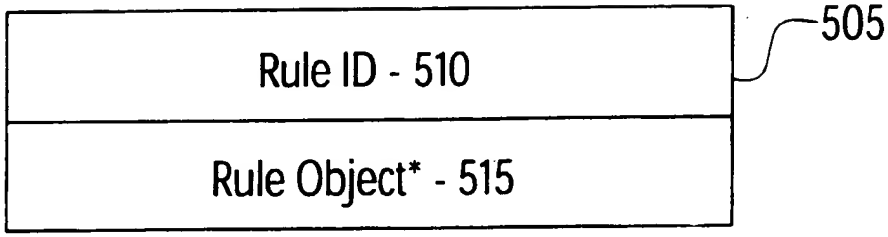
505
Rule ID - 510
Rule Object* - 515

FIG. 5a

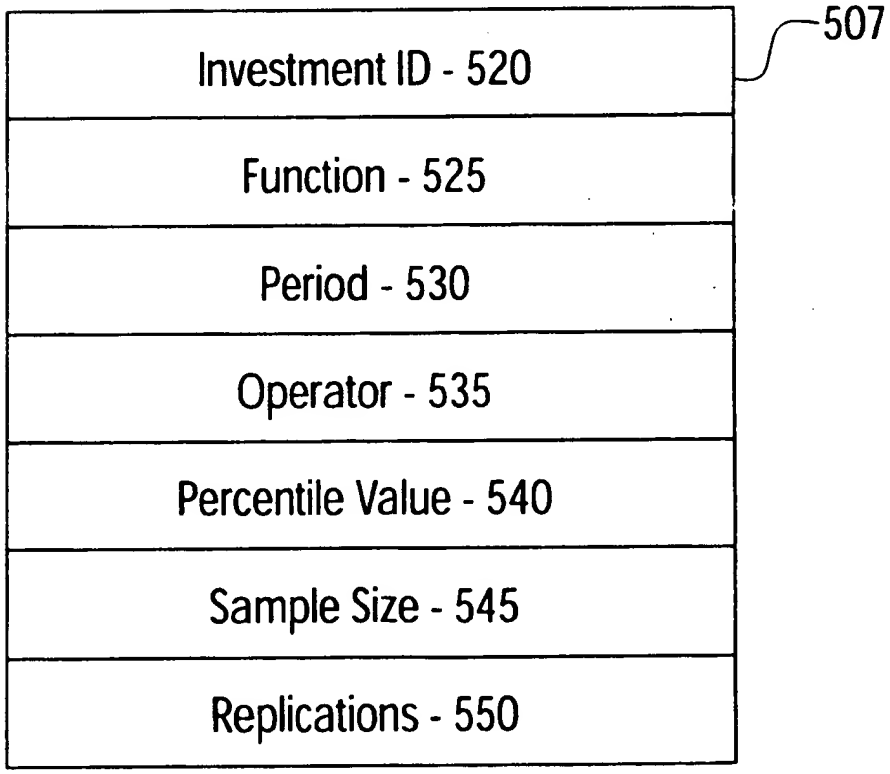
507
Investment ID - 520
Function - 525
Period - 530
Operator - 535
Percentile Value - 540
Sample Size - 545
Replications - 550

FIG. 5b

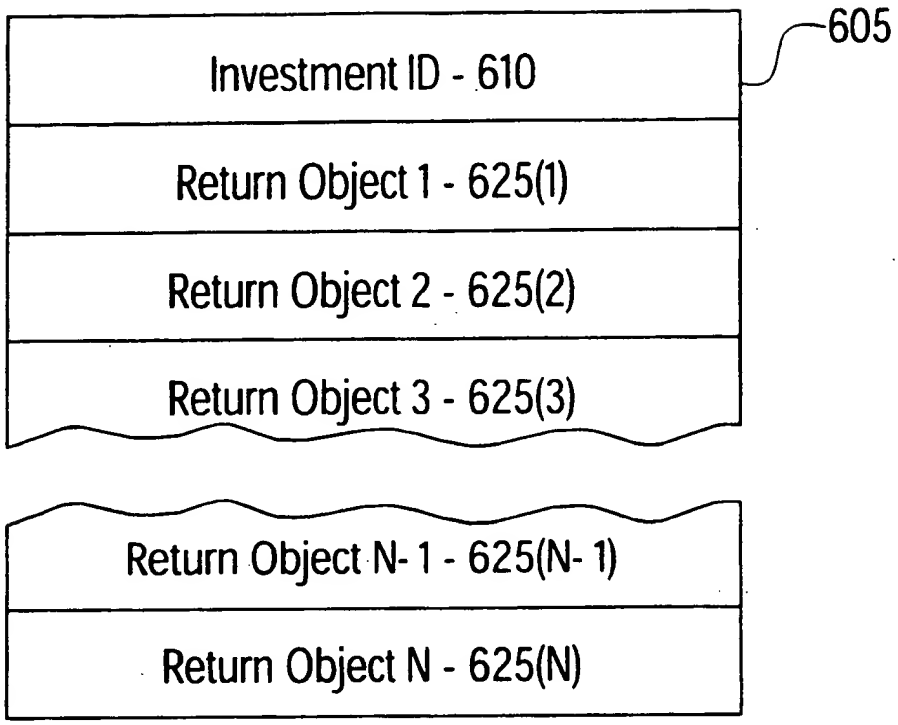
605
Investment ID - 610
Return Object 1 - 625(1)
Return Object 2 - 625(2)
Return Object 3 - 625(3)
Return Object N- 1 - 625(N- 1)
Return Object N - 625(N)

FIG. 6a

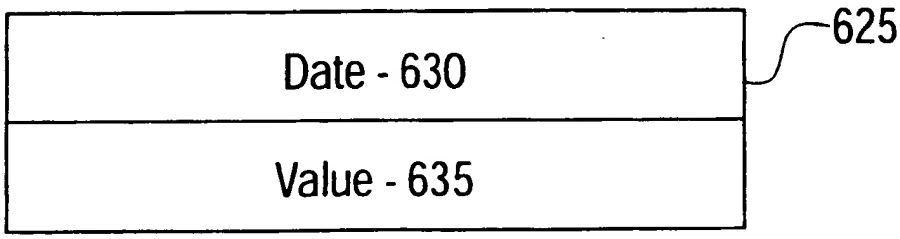
625
Date - 630
Value - 635

FIG. 6b

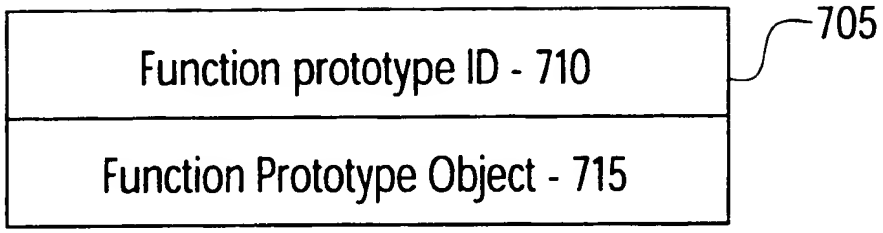
Function prototype ID - 710
Function Prototype Object - 715
705

FIG. 7

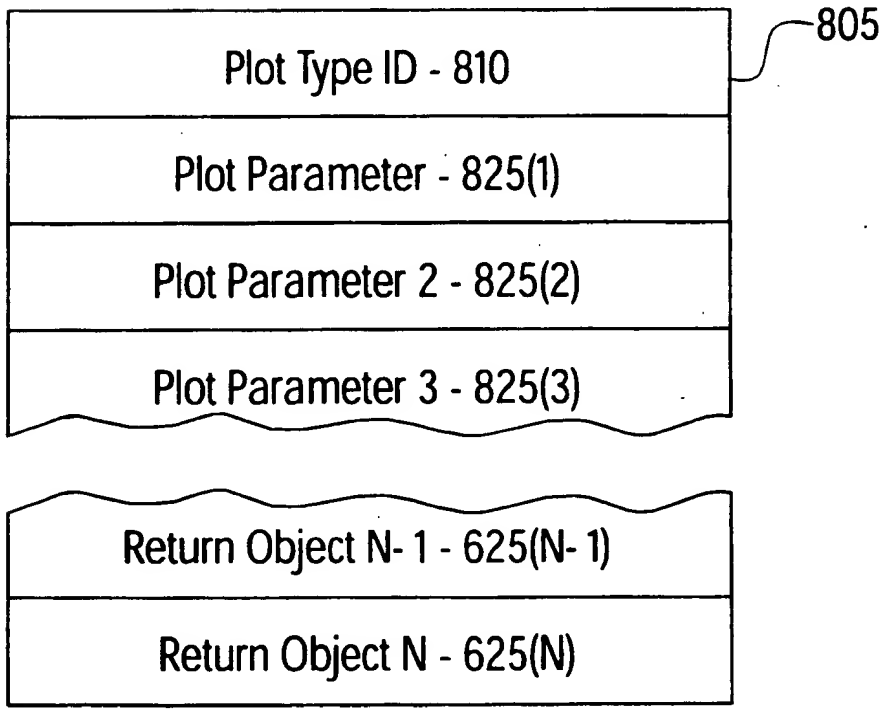
Plot Type ID - 810
Plot Parameter - 825(1)
Plot Parameter 2 - 825(2)
Plot Parameter 3 - 825(3)
805
Return Object N- 1 - 625(N- 1)
Return Object N - 625(N)

FIG. 8

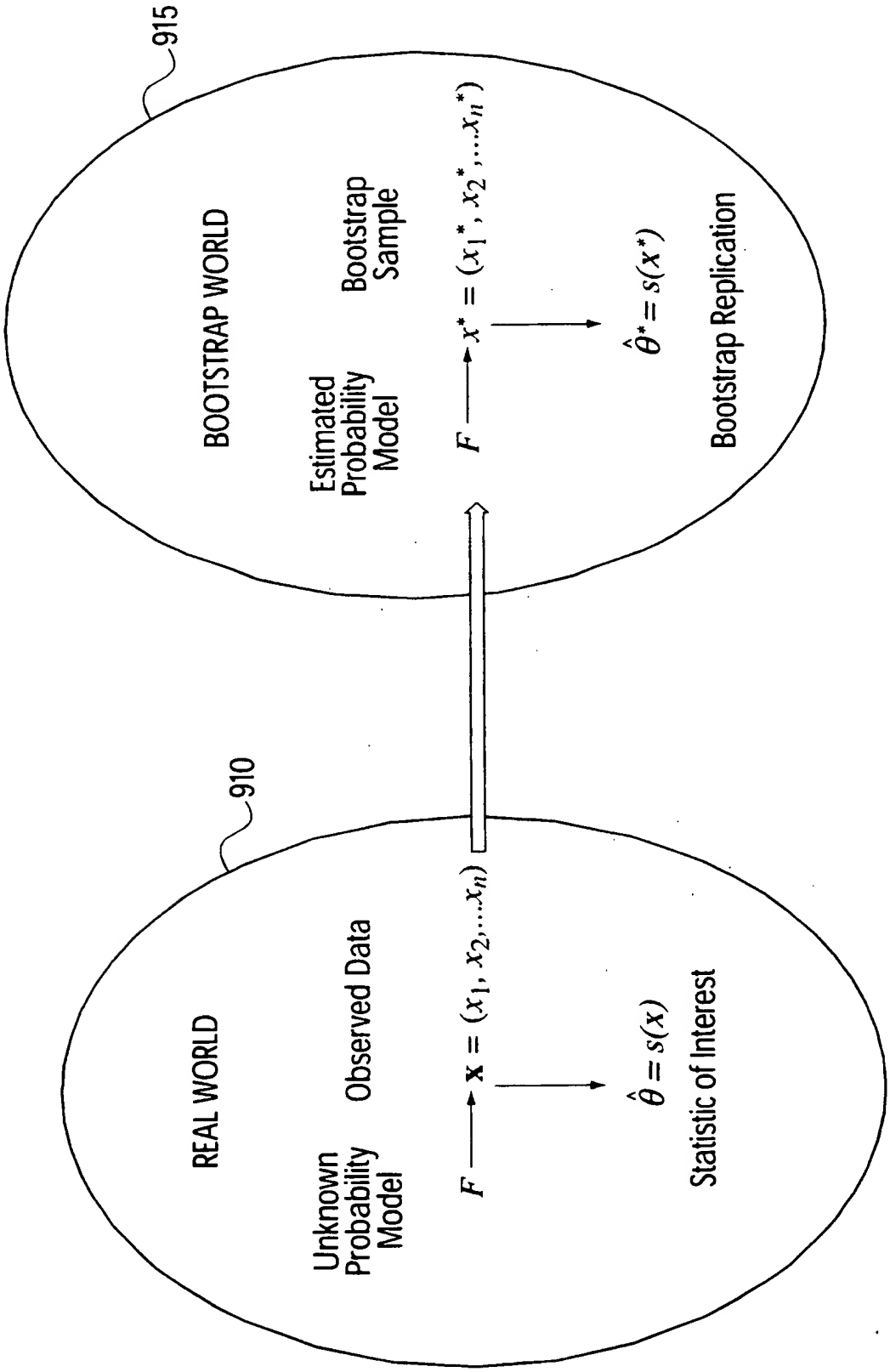
915
BOOTSTRAP WORLD
Estimated Probability Model
Bootstrap Sample
$F \longrightarrow x^* = (x_1^*, x_2^*, \ldots x_n^*)$
$\hat{\theta}^* = s(x^*)$
Bootstrap Replication
910
REAL WORLD
Unknown Probability Model
Observed Data
$F \longrightarrow \mathbf{x} = (x_1, x_2, \ldots x_n)$
$\hat{\theta} = s(x)$
Statistic of Interest

FIG. 9a

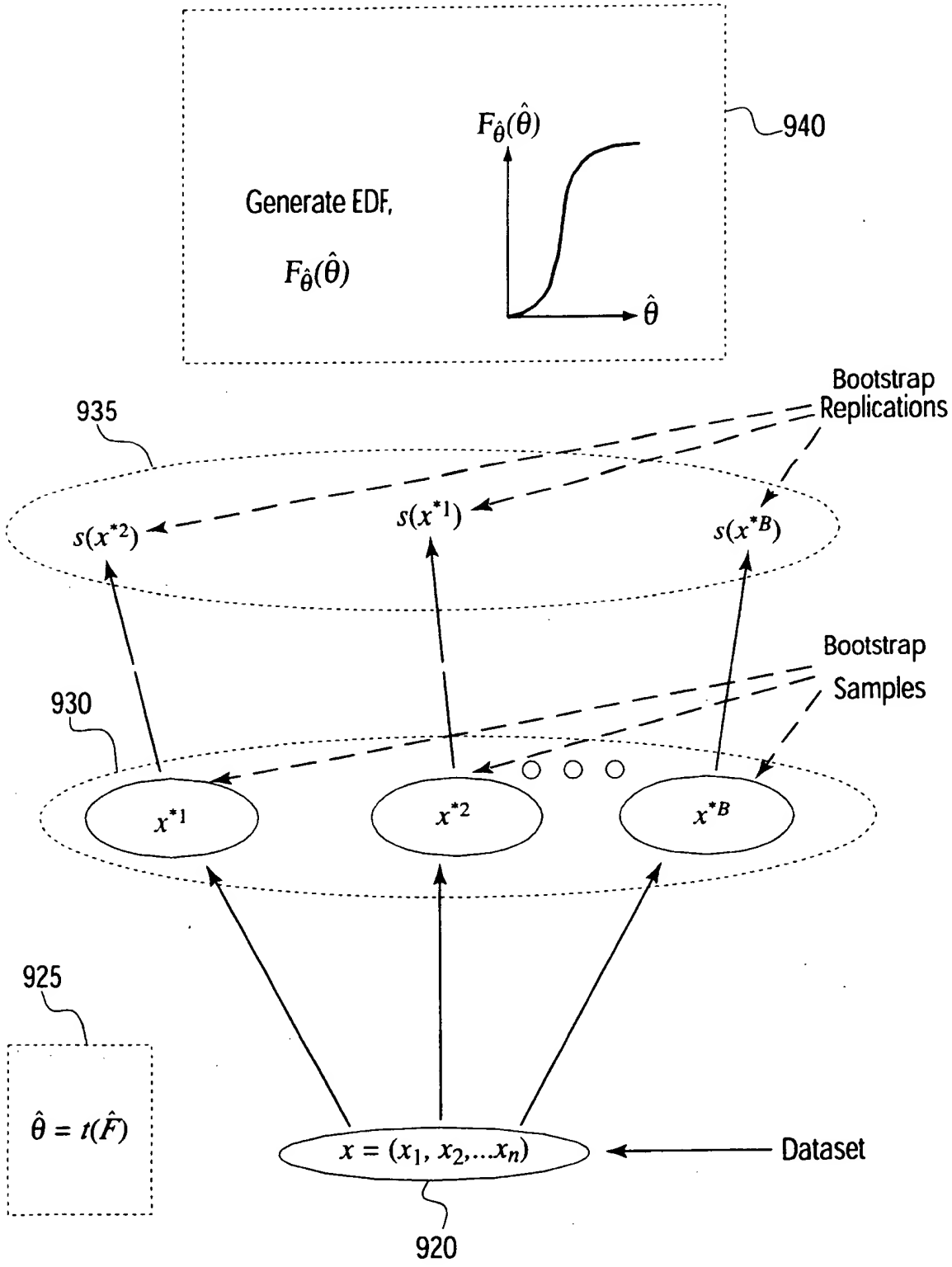
940
Generate EDF,
$F_{\hat{\theta}}(\hat{\theta})$
$F_{\hat{\theta}}(\hat{\theta})$
$\hat{\theta}$
Bootstrap Replications
935
$s(x^{*2})$
$s(x^{*1})$
$s(x^{*B})$
Bootstrap Samples
930
x^{*1}
x^{*2}
x^{*B}
925
$\hat{\theta} = t(\hat{F})$
$x = (x_1, x_2, \ldots x_n)$
Dataset
920

FIG. 9b

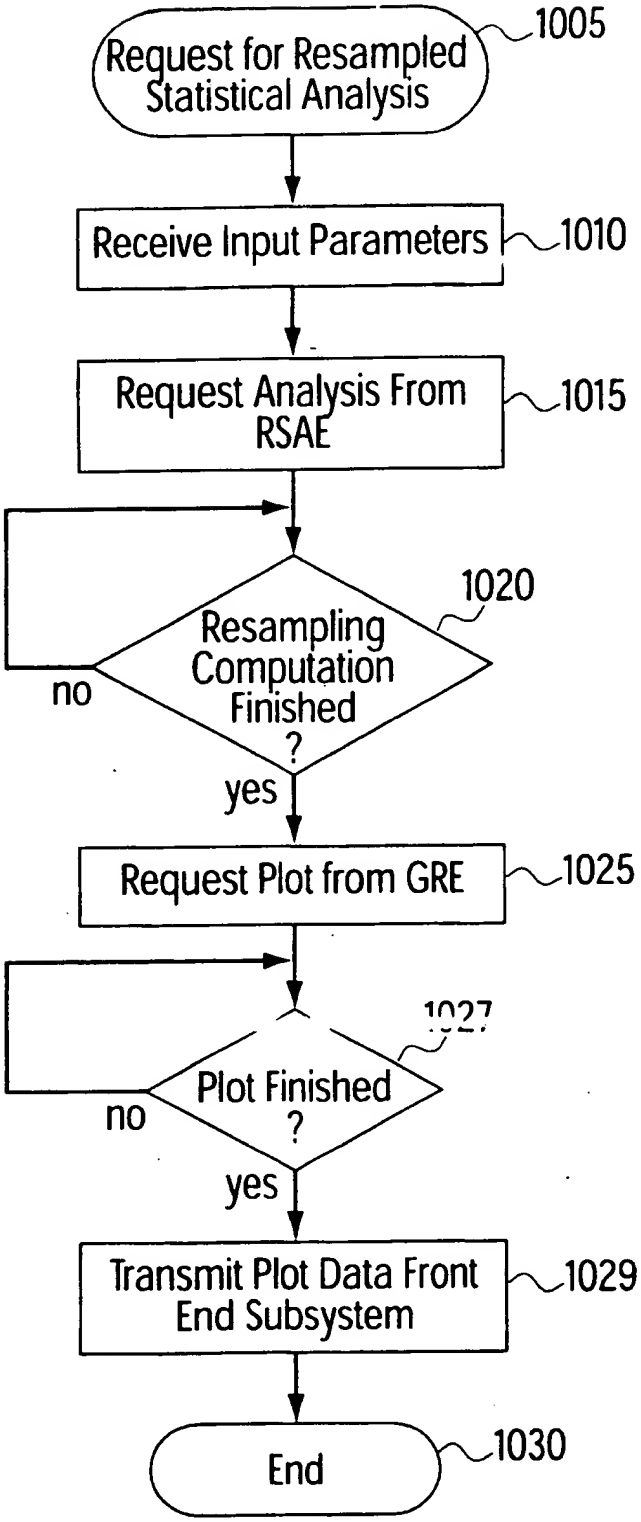
Request for Resampled Statistical Analysis
1005
Receive Input Parameters
1010
Request Analysis From RSAE
1015
Resampling Computation Finished ?
1020
no
yes
Request Plot from GRE
1025
Plot Finished ?
1027
no
yes
Transmit Plot Data Front End Subsystem
1029
End
1030

FIG. 10

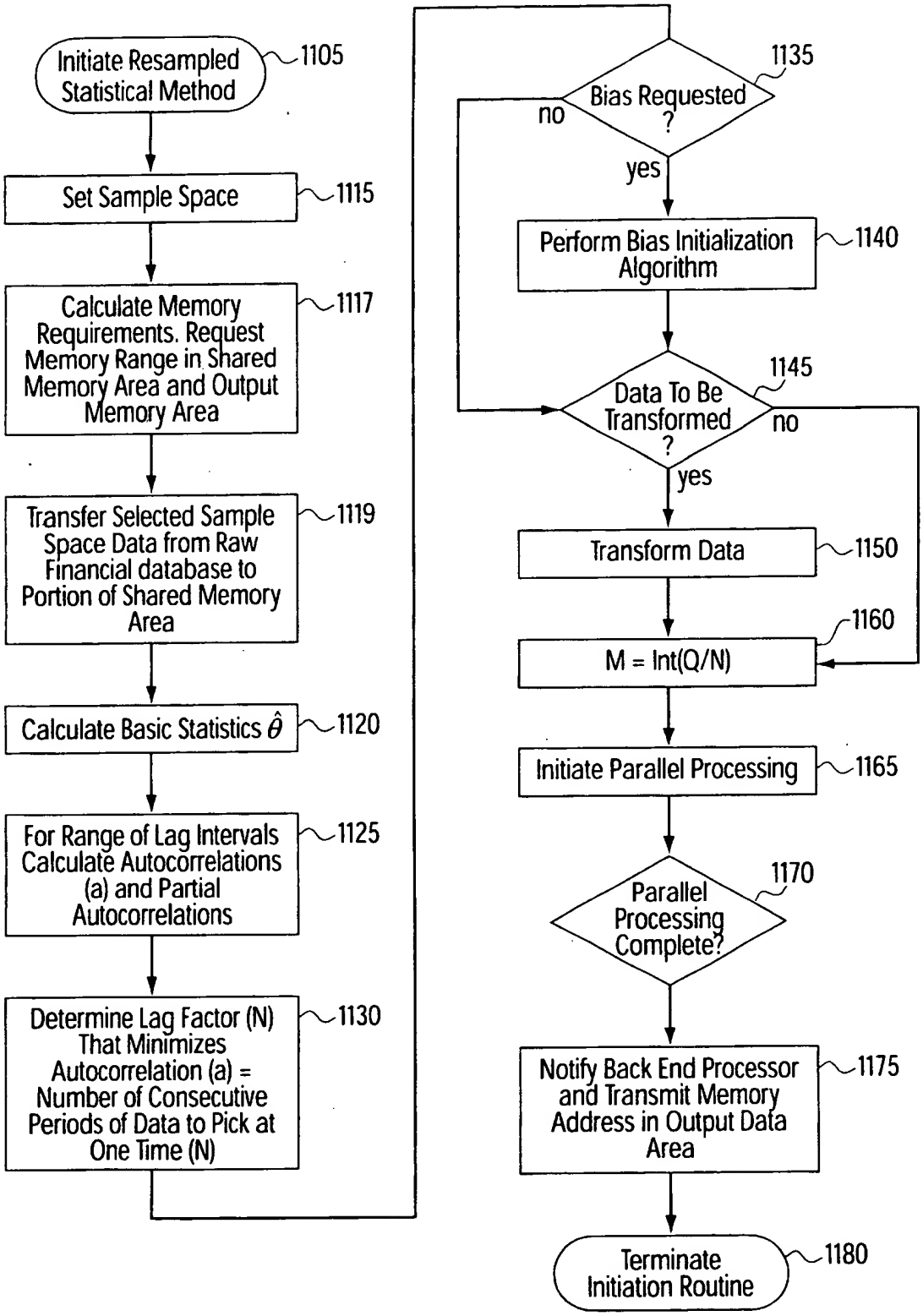
Initiate Resampled Statistical Method
1105
Set Sample Space
1115
Calculate Memory Requirements. Request Memory Range in Shared Memory Area and Output Memory Area
1117
Transfer Selected Sample Space Data from Raw Financial database to Portion of Shared Memory Area
1119
Calculate Basic Statistics $\hat{\theta}$
1120
For Range of Lag Intervals Calculate Autocorrelations (a) and Partial Autocorrelations
1125
Determine Lag Factor (N) That Minimizes Autocorrelation (a) = Number of Consecutive Periods of Data to Pick at One Time (N)
1130
Bias Requested ?
1135
no
yes
Perform Bias Initialization Algorithm
1140
Data To Be Transformed ?
1145
no
yes
Transform Data
1150
M = Int(Q/N)
1160
Initiate Parallel Processing
1165
Parallel Processing Complete?
1170
Notify Back End Processor and Transmit Memory Address in Output Data Area
1175
Terminate Initiation Routine
1180

FIG. 11

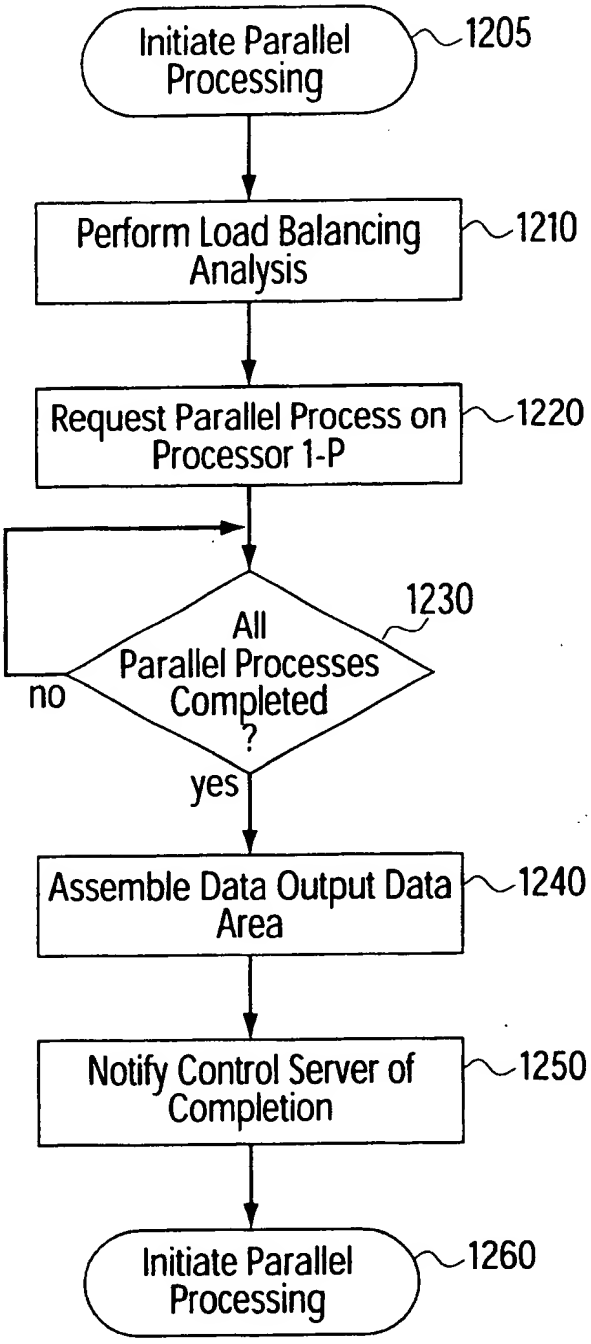
Initiate Parallel Processing
1205
Perform Load Balancing Analysis
1210
Request Parallel Process on Processor 1-P
1220
All Parallel Processes Completed ?
1230
no
yes
Assemble Data Output Data Area
1240
Notify Control Server of Completion
1250
Initiate Parallel Processing
1260

FIG. 12

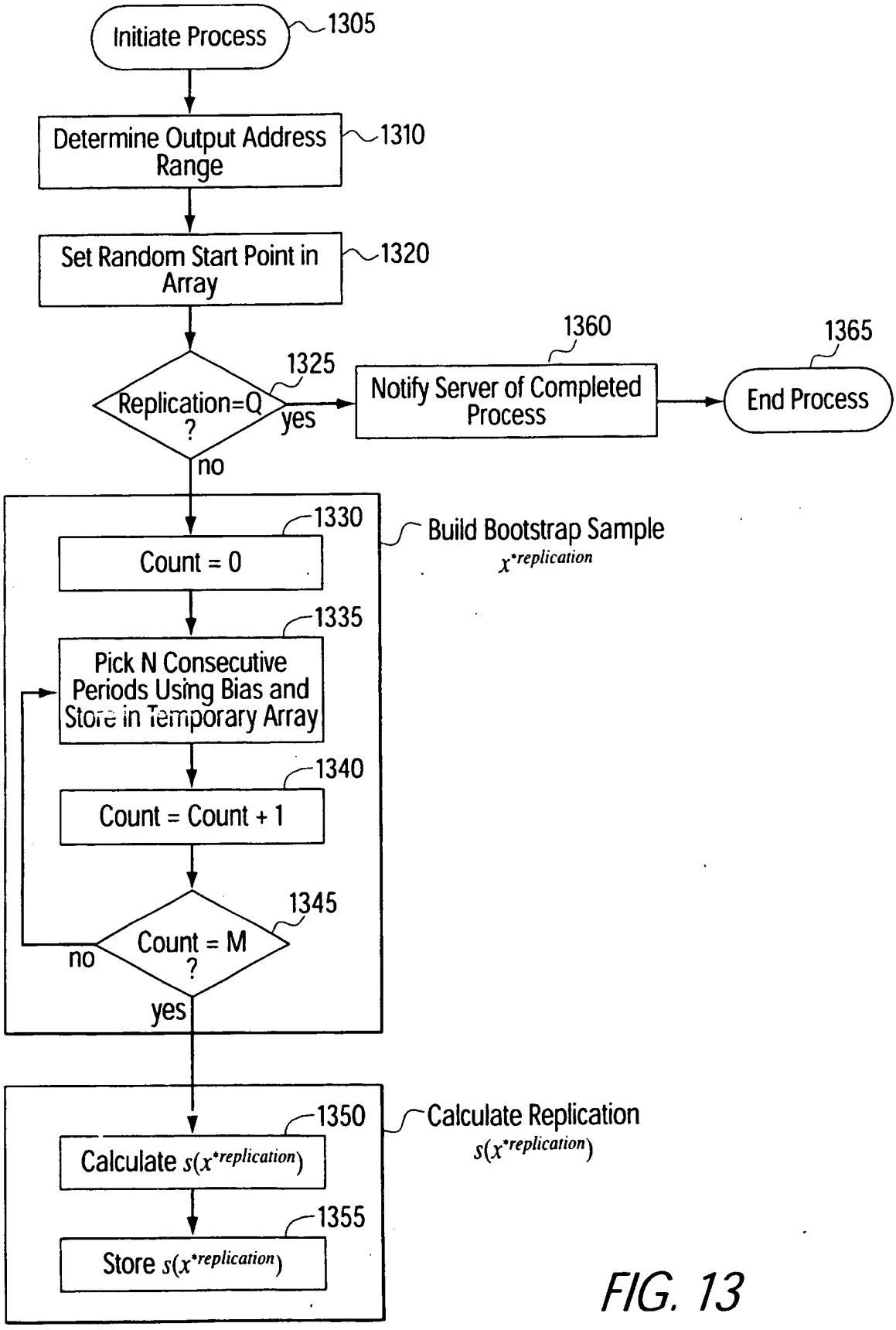
Initiate Process
1305
Determine Output Address Range
1310
Set Random Start Point in Array
1320
1360
1365
1325
Replication=Q ?
yes
Notify Server of Completed Process
End Process
no
1330
Build Bootstrap Sample
$x^{*replication}$
Count = 0
1335
Pick N Consecutive Periods Using Bias and Store in Temporary Array
1340
Count = Count + 1
1345
Count = M ?
no
yes
1350
Calculate Replication
$s(x^{*replication})$
Calculate $s(x^{*replication})$
1355
Store $s(x^{*replication})$

FIG. 13

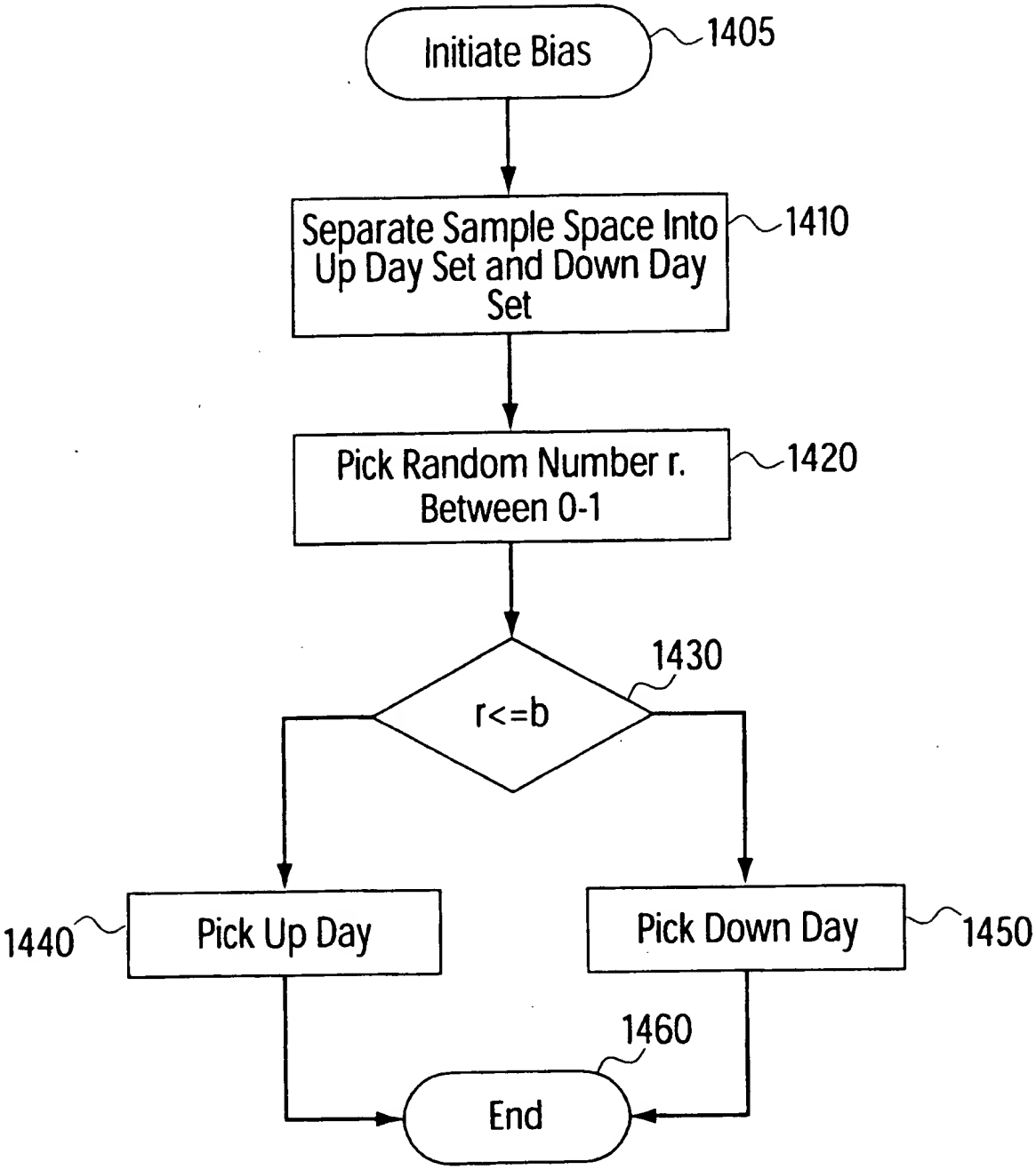
Initiate Bias
1405
Separate Sample Space Into Up Day Set and Down Day Set
1410
Pick Random Number r. Between 0-1
1420
1430
r<=b
1440
Pick Up Day
Pick Down Day
1450
1460
End

FIG. 14

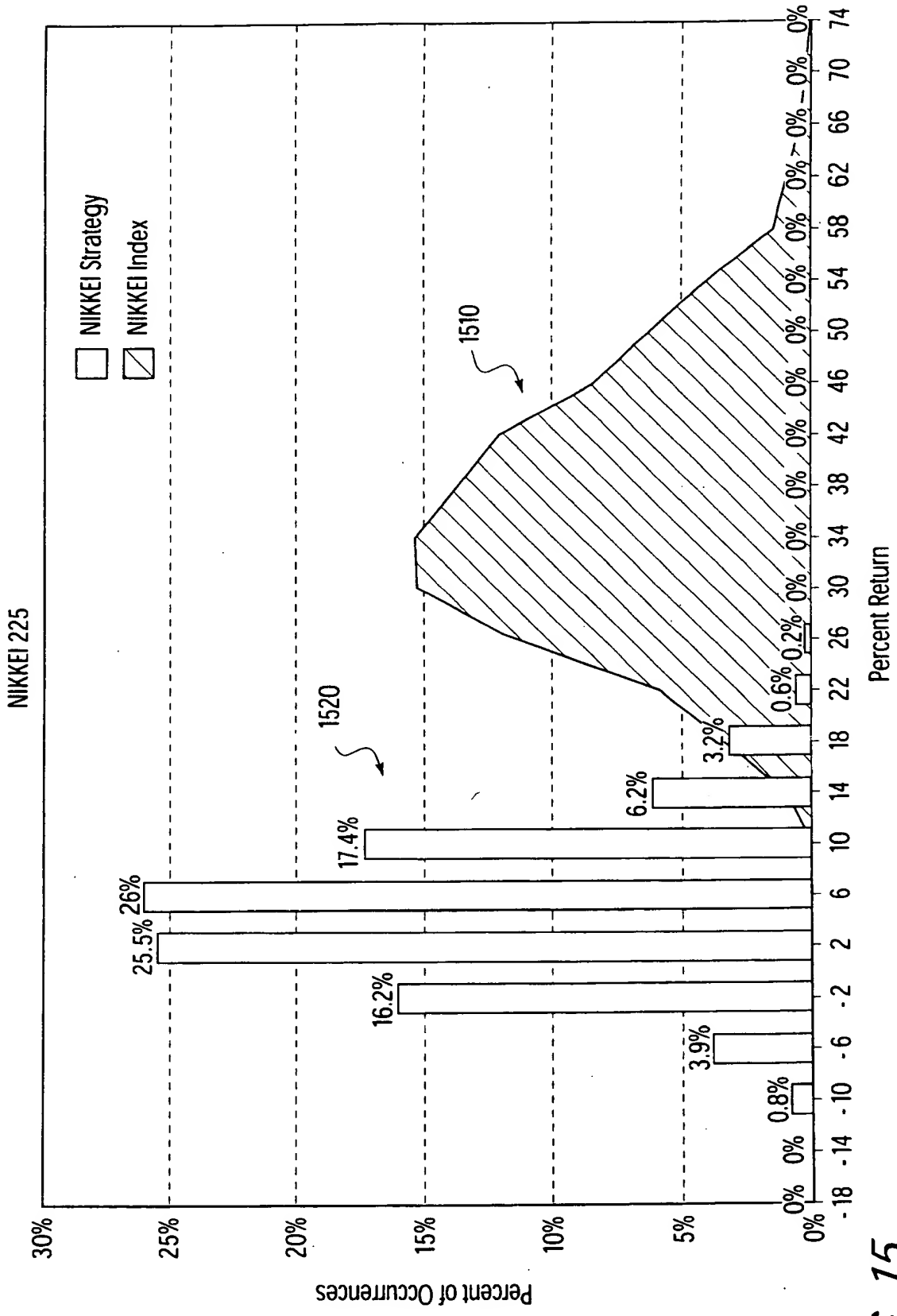
NIKKEI 225
NIKKEI Strategy
NIKKEI Index
1510
1520
Percent of Occurrences
Percent Return
30%
25%
20%
15%
10%
5%
0%
26%
25.5%
17.4%
16.2%
6.2%
3.9%
3.2%
0.8%
0.6%
0.2%
0%
-18
-14
-10
-6
-2
2
6
10
14
18
22
26
30
34
38
42
46
50
54
58
62
66
70
74

FIG. 15

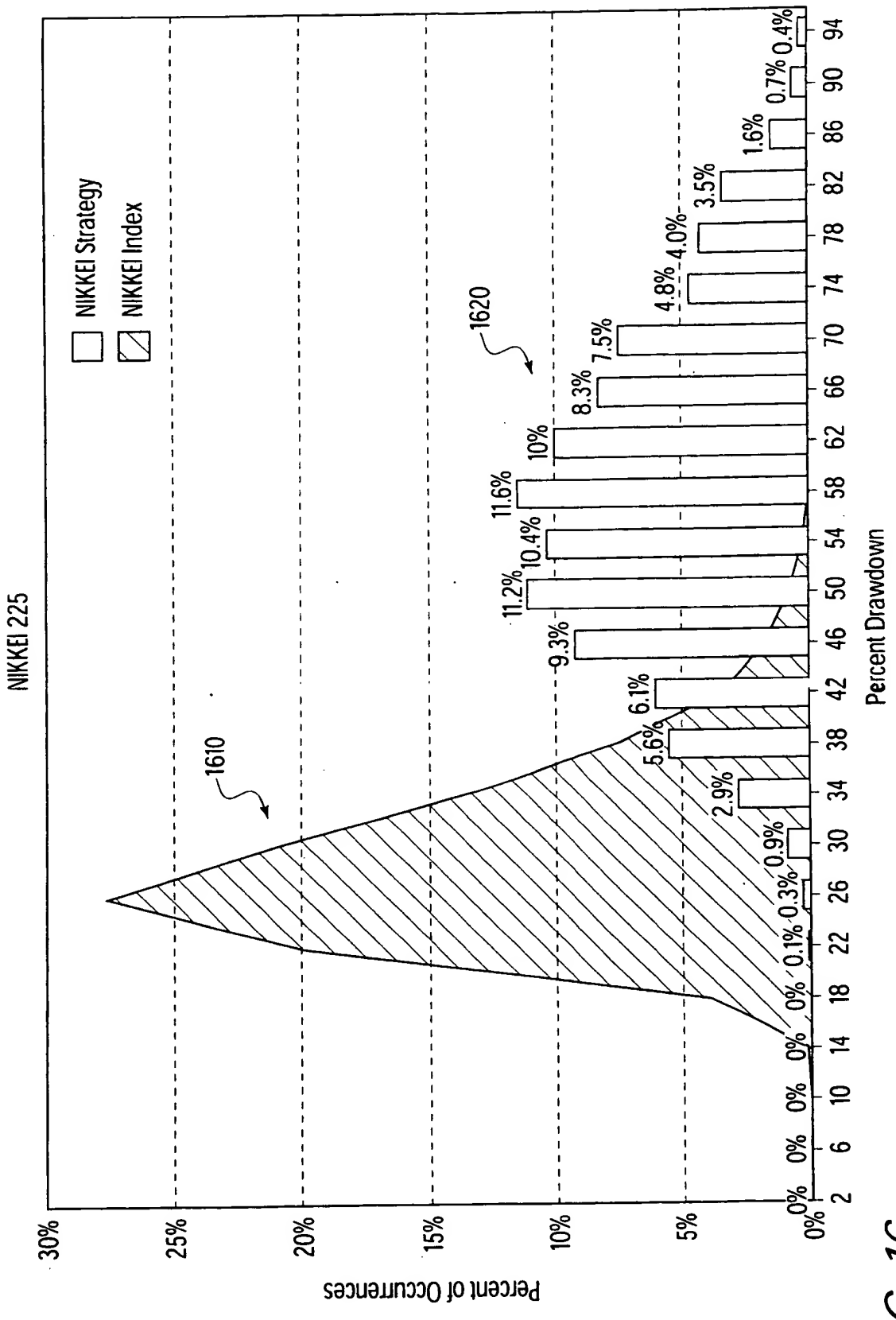
NIKKEI 225
NIKKEI Strategy
NIKKEI Index
1610
1620
Percent of Occurrences
Percent Drawdown
30%
25%
20%
15%
10%
5%
0%
2
6
10
14
18
22
26
30
34
38
42
46
50
54
58
62
66
70
74
78
82
86
90
94
0%
0%
0%
0%
0%
0.1%
0.3%
0.9%
2.9%
5.6%
6.1%
9.3%
11.2%
10.4%
11.6%
10%
8.3%
7.5%
4.8%
4.0%
3.5%
1.6%
0.7%
0.4%

FIG. 16

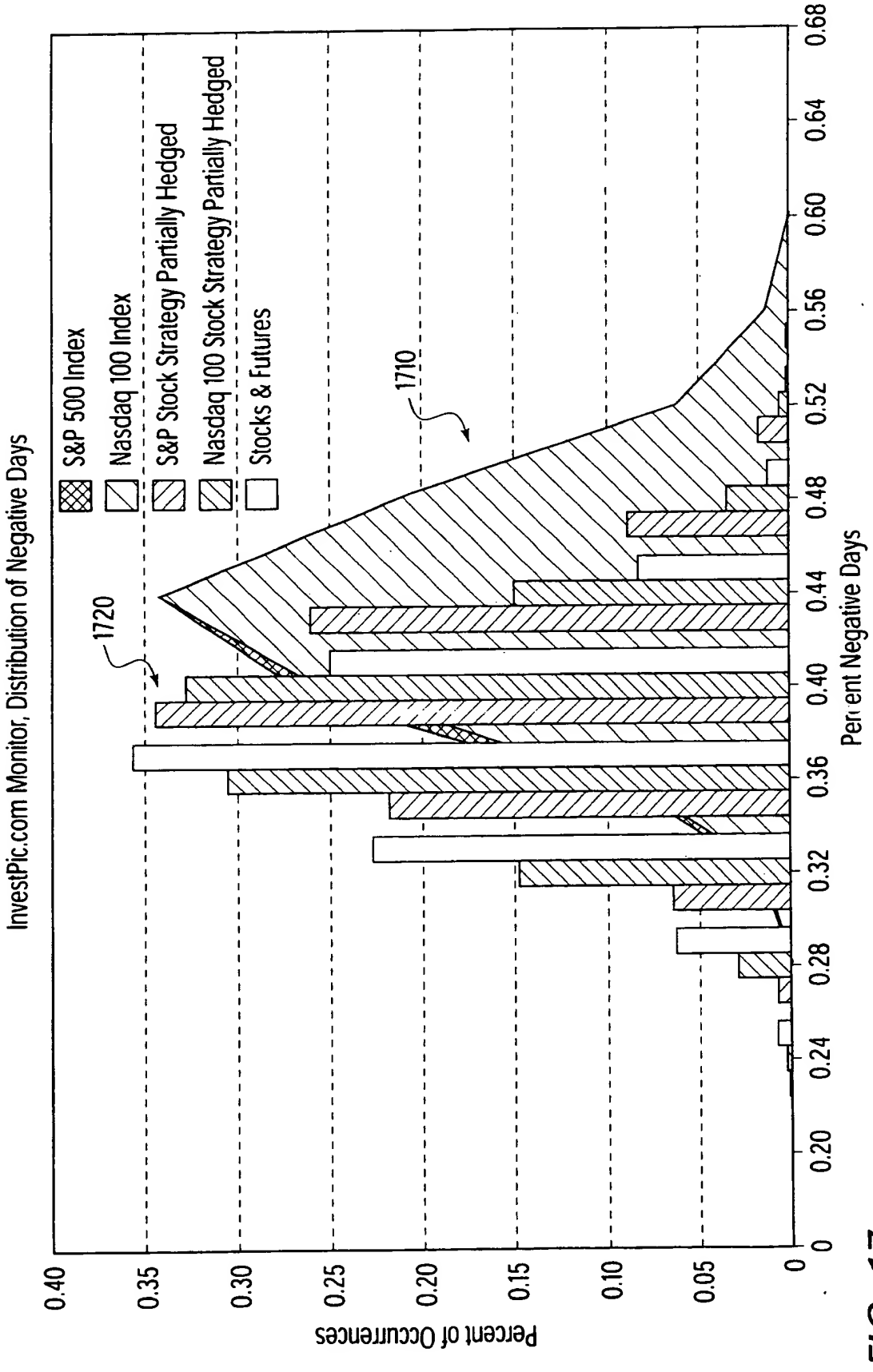
InvestPic.com Monitor, Distribution of Negative Days
S&P 500 Index
Nasdaq 100 Index
S&P Stock Strategy Partially Hedged
Nasdaq 100 Stock Strategy Partially Hedged
Stocks & Futures
1710
1720
Percent of Occurrences
Percent Negative Days
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
0.20
0.24
0.28
0.32
0.36
0.40
0.44
0.48
0.52
0.56
0.60
0.64
0.68

FIG. 17

METHOD AND SYSTEM FOR ANALYSIS, DISPLAY AND DISSEMINATION OF FINANCIAL INFORMATION USING RESAMPLED STATISTICAL METHODS

FIELD OF THE INVENTION

The present invention relates to the area of electronic information systems. In particular, the present invention relates to a method and system for the delivery of financial information using resampled statistical methods over an information network.

BACKGROUND INFORMATION

Investors and financial analysts rely upon electronic information systems for the delivery of accurate financial and investment data and analysis in order to devise meaningful investment strategies. The growth of the Internet and World Wide Web ("WWW") highlights the potential for global distribution of "real time" or "near real time" financial information and analysis. For example, a number of WWW sites provide financial information to clients such as investors and financial analysts.

However, conventional financial information sites do not provide meaningful analysis tools to accurately analyze, forecast and predict the behavior of financial markets. Conventional technology for delivery of financial information over information networks such as the Internet typically allows users to track returns for various investments and perform rudimentary statistical analysis (e.g., computation of the mean and standard deviation) for these investments. However, these rudimentary statistical functions are not useful to investors in forecasting the behavior of financial markets because they rely upon assumptions that the underlying probability distribution function ("PDF") for the financial data follows a normal or Gaussian distribution, which is generally false.

The true distribution of returns for any financial market (and thus of a trading strategy) is unknown. It is therefore incorrect to rely upon a statistical model based on assumptions of normality (e.g., standard deviation). Typically, the PDF for financial market data is heavy tailed (i.e., the histograms of financial market data typically involve many outliers containing important information). Thus, statistical measures such as the standard deviation provide no meaningful insight into the distribution of financial data.

Providing reasonable methods for the analysis of financial market data is essential for investors. Reasonable statistical analysis of financial data should at a minimum provide an accurate assessment of potential financial risk and reward. However, conventional methods, which rely upon assumptions of a Gaussian distribution, are dangerous to investors because these analyses understate the true risk and overstate potential rewards for an investment or trading strategy. Thus, this information is not generally useful and if relied upon promotes imprudent investment decisions. In general, the heavy tailed nature of financial data presents significant challenges in providing meaningful statistical analysis.

SUMMARY OF THE INVENTION

The present invention provides a method and system for the statistical analysis, display and dissemination of financial data over an information network such as the Internet and WWW. The present invention utilizes resampled statistical methods for the analysis of financial data. Resampled statistical analysis provides a meaningful and reasonable statistical description of financial information, which typically escapes modeling using parametric methods (i.e., assumptions of a Gaussian distribution).

The present invention includes a financial information network node that is coupled to an information network such as the Internet. The financial information network node includes a front end subsystem, a resampled statistical analysis engine ("RSAE") and a graphics rendering engine ("GRE"). The front end subsystem provides a graphical user interface ("GUI") that allows clients also coupled to the information network to submit requests for resampled statistical analysis of various financial investments and receive graphical display of the results. The RSAE performs resampled statistical analysis of financial data in response to user queries and incorporates routines to preserve temporal correlation in financial data, which necessarily provides more accurate analysis. In addition, the RSAE provides for user control of a number of parameters to simulate various financial environmental conditions. For example, according to one embodiment, the RSAE allows a user to simulate either bull or bear market conditions by setting a bias parameter that controls a degree of randomness in the resampling process. The GRE generates a graphical display of statistical distributions generated by the RSAE.

According to one embodiment, the present invention employs a parallel processing architecture to speed generation of the resampled statistics. The parallel architecture is afforded by the nature of the resampling algorithm itself, which permits the financial data to be vectorized. This parallel processing architecture provides at least two significant advantages. First, the architecture permits the delivery and processing of financial data in compressed time frames, which facilitates "real time" or "near real time" statistical analysis. In addition, the parallel computation scheme provides the ability to perform statistical analysis on a large number of financial entities (e.g., a mutual fund or hedge fund) through a weighting process.

According to one embodiment of the present invention for implementation on the Internet, a financial information site is coupled to the Internet via a front end subsystem including a WWW server. The financial information site includes a front end subsystem, a RSAE and a GRE. In addition, the financial information site maintains a database of financial data for any number of financial entities such as companies, mutual funds etc. The financial information site also maintains a database of clients that have registered with the financial information site and desire to obtain statistical analysis of financial data.

In order to perform a resampled statistical analysis, a query is received from a client via the front end subsystem. A client may specify a number of parameters including an investment or investments (e.g., a portfolio) to be analyzed, a financial function, a sample size, a period, a type of plot and a bias parameter, which controls the randomness of the resampling process. Based upon the parameters specified by the client, the RSAE performs a resampled statistical analysis of relevant financial data. The GRE then produces a distribution plot based upon the output generated by the RSAE, which is presented to the client via the front end subsystem.

According to one embodiment of the present invention, the RSAE performs at least three types of financial functions on financial data. A gross rate of return function provides analysis of the gross rate of returns for an investment over a specified time period. A maximum drawdown function provides analysis of a maximum drawdown for an invest-

ment over a specified period. A monitor function provides analysis of a number of "up" and "down" days for a particular investment over a period of time.

The financial information site also provides functionality for storing a set of client specified alert rules that are used to automatically monitor the behavior of investments based upon a resampled statistical analysis process and notify clients of the financial information site when the behavior of a particular investment violates a specified rule.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a network architecture that illustrates the relationship between a financial information site and a client according to one embodiment of the present invention.

FIG. **2** is a detailed block diagram of a financial information site according to one embodiment of the present invention.

FIG. **3** depicts the structure of a client record that is stored in a client database at a financial information site according to one embodiment of the present invention.

FIG. **4** depicts the structure of an investment record that is stored in an investment database at a financial information site according to one embodiment of the present invention.

FIG. **5***a* depicts the structure of an alert rule record that is stored in an alert rules database at a financial information site according to one embodiment of the present invention.

FIG. **5***b* depicts the structure of a rule object record according to one embodiment of the present invention.

FIG. **6***a* depicts a data structure for storing financial data in a financial database according to one embodiment of the present invention.

FIG. **6***b* depicts a data structure for storing a financial return according to one embodiment of the present invention.

FIG. **7** depicts a data structure for storing a function prototype in a function database at a financial information site according to one embodiment of the present invention.

FIG. **8** depicts a data structure for storing plot information in a plot database at a financial information site according to one embodiment of the present invention.

FIG. **9***a* (reprinted from Efron and Tibshirani) depicts the underlying theory of the bootstrap method.

FIG. **9***b* depicts a procedure for performing a bootstrap method to generate a distribution of bootstrap replications according to one embodiment of the present invention.

FIG. **10** is a flowchart of steps for performing a resampled analysis of an investment and generating a graphical output according to one embodiment of the present invention.

FIG. **11** is a flowchart that depicts a set of steps to initiate a resampled statistical analysis of financial data using a parallel processing architecture according to one embodiment of the present invention.

FIG. **12** is a flowchart of a parallel processing control process according to one embodiment of the present invention.

FIG. **13** is a flowchart of a set of steps for performing a resampled statistical analysis according to one embodiment of the present invention.

FIG. **14** is a flowchart of a set of steps for performing a biasing procedure according to one embodiment of the present invention.

FIG. **15** is an exemplary plot of a resampled statistical analysis comparing two investment strategies with respect to gross rate of returns according to one embodiment of the present invention.

FIG. **16** is an exemplary plot of a resampled statistical analysis comparing two investment strategies with respect to maximum drawdown returns according to one embodiment of the present invention.

FIG. **17** is an exemplary plot of a resampled statistical analysis comparing multiple investment strategies with respect to a monitor function according to one embodiment of the present invention.

DETAILED DESCRIPTION

Although the embodiments described herein utilize the Internet and WWW, the present invention is compatible with any type of information network public or private and thus, the embodiments described herein are not intended to limit the scope of the claims appended hereto. For example, the present invention could be implemented using a private Intranet, local area network (LAN), metropolitan area network (MAN), wide area network (WAN) or even a wireless network

FIG. **1** is a block diagram of a network topology that illustrates the relationship between the Internet, a financial information site and various clients according to one embodiment of the present invention. Based upon queries submitted by clients, financial information site **119** performs resampled statistical analysis of financial data and provides a graphical display of distribution results. Details of the functionality provided by financial information site **119** are described below.

Clients **105***a*–**105***c* communicate with financial information site **119** via Internet **114**. According to the embodiment depicted in FIG. **1**, financial information site **119** is coupled to Internet **114** via T1 line **130***b*. Client **105***a* illustrates a typical narrowband client coupled to Internet **114** via a dial-up connection described in more detail below. Client **105***b* illustrates a typical broadband client coupled to Internet **114** via a cable modem. Client **105***c* illustrates a corporate client that is coupled to Internet via T1 line **130***c* and server **151**. Corporate client **105***c* includes three network nodes **171***a*–**171***c* that share bandwidth on Ethernet **161**. Although FIG. **1** illustrates three clients (**105***a*–**105***c*), it is to be understood that financial information site **119** may serve any arbitrary number of clients **105** limited only by the processing power and bandwidth available.

As illustrated in FIG. **1**, client **105***a* communicates with financial information site **119** via personal computer **112***a*, modem **115***a*, POTS telephone line **117** and Internet service provider **120***a*. Internet service provider **120***a* includes modem bank **121** and router **135***a* that routes packets received from modem bank **121** onto Internet **114** via T1 line **130***a*. Packets are routed over Internet **114** to client gateway server **140***a* at financial information site **119** via T1 line **130***b*.

Client **105***a* utilizes personal computer **112***a* to navigate Internet/World-Wide-Web (WWW **114** via browser software (not shown) and display device (not shown). The browser software permits navigation between various file servers connected to Internet **114**, including client gateway server **140***a* at financial information site **119**. The browser software also provides functionality for rendering of files distributed on the Internet (i.e., through plug-ins or Active X controls).

In order to transmit data to financial information site **119**, personal computer **112***a* transmits signals through a dial-up connection utilizing modem **115***a*. Modem **115***a* performs modulation of digital signals generated by personal com-

puter **112***a* onto an analog carrier signal for transmission over the public switched telephone network ("PSTN") (not shown). Modem **115***a* also performs demodulation of signals received over local lines (e.g., 117) from the PSTN extracting digital byte codes from a modulated analog carrier.

Signals are received at ISP **120***a*, which is connected to the PSTN through modem bank **121**. Digital IP packets are then transmitted via Internet **114** and various routers (not shown) to WWW server **140***a*. IP packets are also transmitted in the reverse direction from WWW server **140***a* to personal computer **112***a*.

Client **105***b* is coupled to Internet **114** via a broadband cable connection. In particular, personal computer **112***b* transmits packets via cable modem **115***b* to ISP **120***b* where the packets are routed over Internet **114** to client gateway server **140***a*. Packets from financial information site **119** traverse a reverse path to client **105***b* . Similar to client **105***a*, client **105***b* utilizes browser software to navigate Internet **114** and WWW.

Corporate client **105***c* includes network nodes **171***a*–**171***c*, which are coupled to Internet via Ethernet **161**, server **151** and T1 line **130***c*. Network nodes **171***a*–**171***c* may communicate with financial information site **119** via Ethernet, server **151**, T1 line **130***c*, Internet **114** and T1 line **130***b*. Similar to clients **105***a*–**105***b* , it is assumed that users at network nodes **171***a*–**171***c* utilize browser software to navigate Internet **114** and WWW.

The specific nature of clients **105***a*–**105***c* and the methods through which they are coupled to Internet **114** depicted in FIG. **1** are merely exemplary. The present invention is compatible with any type of Internet client and/or connection (broadband or narrowband). In general, it is to be understood that clients **105** may connect to Internet **114** using any potential medium whether it be a dedicated connection such as a cable modem, T1 line, DSL ("Digital Subscriber Line"), a dial-up POTS connection or even a wireless connection.

FIG. **2** is a detailed block diagram of a financial information site according to one embodiment of the present invention. Financial information site **119** includes front end subsystem **129**, RSAE **139**, GRE **149**, back end server **140**, client database **150***g* and alert rules database **150***c*.

Front end subsystem **129** includes client/gateway server **140***a*, which is coupled to GUI database **150***a*. Front end subsystem **129** provides a GUI, which allows clients **105** to transmit information to and receive information from financial information site **119**. According to one embodiment GUI database **150***a* stores HTML ("Hypertext Markup Language") code (i.e., WWW pages) relating to various information and functions provided by financial information site **119**. For example, GUI database **150***a* may store a HTML "home page" for financial information site **119** or HTML pages including forms, which allow the input of data at financial information site **119**.

Front end subsystem **129** also includes SMTP ("Simple Mail Transport Protocol") server **140***f* SMTP server **140***f* performs transmission of e-mail messages to clients **105** associated with financial information site **119** in order to provide notification regarding various events (as described in more detail below).

Client gateway server **140***a* communicates with back end server **140***b*, which controls and orchestrates the large-scale processing of data at financial information site **119**. In particular, back end server **140***b* handles responses to requests from clients **105** for resampled statistical analysis of investments. For example, back end server **140***b* submits requests to RSAE for resampled statistical analysis of financial data and submits requests to GRE for graphical rendering of output generated by RSAE. Back end server **140***b* communicates with control server **140***c* at RSAE **139**, graphics rendering server **140***e* at GRE **149** and SMTP server **140***f* at front end 1 subsystem **29**.

RSAE **139** includes control server **140***c*, parallel process control server **140***d*, parallel processors **112***a*–**112***e* (each including local respective cache **112***a***1**–**112***e***1**), financial database **150***d*, investment database **150***e*, function database **150***f*, shared memory area **160***a* and output data area **160***b*. Note that RSAE **139** depicted in FIGS. **1**–**2** utilizes a parallel processing architecture. This parallel scheme is merely exemplary and is not intended to limit the scope of the claims appended hereto. Other embodiments may not rely upon a parallel processing architecture at RSAE **139**.

Control server **140***c* provides communication functions between back end server **140***b* and RSAE **139** and controls the overall operation of a resampled statistical analysis process. Control server **140***c* is coupled to parallel process control server **140***d* and shared memory area **160***a*. Shared memory area **160***a* stores sample data for financial investments currently being analyzed by RSAE **139**. As described in detail below, control server **140***c* receives requests for parallel processing computations from back end server **140***b*, performs certain initialization functions, loads appropriate data into shared memory **160***a* and forwards these requests to parallel process control server **140***d* for performance. Control server **140***c* then waits for a completion signal from parallel process control server **140***d* and provides the output results to back end server **140***b* for further processing (e.g., graphical rendering via GRE **149**).

Control server **140***c* is also coupled to financial database **150***d*, investment database **150***e*, function database **150***f* and shared memory area **160***a*. Financial database **150***d* (described in more detail below) stores financial sample data relating to particular investments. Investment database **150***e* (described in more detail below) stores financial data regarding investments for which clients may be interested in performing resampled statistical analysis (i.e., stocks, mutual finds, etc.). Function database **150***f* (described in more detail below) stores function prototypes for functions to be performed on financial data.

Parallel process control server **140***d* is coupled to parallel processors **112***a*–**112***e* and output data memory area **160***b*. Parallel processors **112***a*–**112***e*, which are each coupled to a respective local cache **112***a***1**–**112***e***1** and shared memory area **160***a*, perform resampled statistical analysis of sample data stored in shared memory area **160***a* (i.e., resampled statistical computations). Parallel process control server **140***d* (described in more detail below) orchestrates and controls parallel computation processes running on parallel processors **112***a*–**112***e*. In particular, parallel process control server **140***d* requests initialization of resampled statistical analysis of data stored in shared memory area **160***a* from individual processors **112***a*–**112***e*. Upon completion of all parallel processes running on processors **112***a*–**112***e*, parallel process control server **140***d* retrieves the results stored in local caches **112***a***1**–**112***e***1** and stores the aggregate data in output data area **160***b* where it can be processed further (e.g., in GRE **149**).

GRE **149** performs graphical rendering (e.g., plots) of output data generated by RSAE **139**. GRE **149** includes graphics rendering engine server **140***e*, which is coupled to plot database **150***b*. As described in detail below, plot database **150***b* stores data regarding the rendering and for-

matting of distribution plots generated by graphics rendering engine server **140***e*.

Back end server **140***b* is also coupled to client database **150***g* and alert rules database **150***c*. Client database **150***g* stores information related to clients that have registered with financial information site **119**. Alert rules database **150***c* stores data pertaining to client specified rules for alerting clients to near real time behavior of investments. According to one embodiment of the present invention, clients are alerted to rule violations by e-mail via SMTP server **140***f*, which is also coupled to back end server **140***b*.

FIG. **3** depicts the structure of a client record that is stored in a client database **150***g* at a financial information site **119** according to one embodiment of the present invention. Each client record **305** includes client ID field **310**, client password field **315**, portfolio* pointer field **320**, alert rules* pointer field **325**, e-mail address field **330**, billing parameter field **335** and preference parameter fields **340**(1)–**340**(N).

Client ID field **310** stores a unique 16-byte character array or pointer to a character array of a client that has registered with financial information site **119**. Client password field **315** stores a unique 16-byte character array or pointer to a character array of a password associated with a client **105**. Clients **105** may establish a client ID and password upon registration with financial information site **119**.

Portfolio* pointer field **320** stores a pointer to a linked list of investments that a client **105** has selected for tracking using financial information site **119**. According to one embodiment of the present invention, each link in the linked list stores an identifier of an investment entity as described in more detail below. Alert rules* pointer field **340** stores a linked list of alert rule record IDs (discussed in more detail below) that specify particular financial alert rules that are monitored by financial information site **119** and associated with individual clients **105**. These rules are used to notify individual clients **105** of the occurrence of particular events they wish to follow based upon a resampled statistical analysis of financial data. E-mail address field **330** stores a 32-byte character array or pointer to a character array of an e-mail address of a client **105**. Billing parameter field **335** stores a pointer to billing object record that includes billing information for a client **105**. Preference parameters **340**(1) –**340**(N) store preference parameters related to customization functions associated with financial information site **119**.

FIG. **4** depicts the structure of an investment record that is stored in an investment database **150***e* at a financial information site **119** according to one embodiment of the present invention. Investments may represent stocks, mutual funds, etc. Each investment record **405** includes investment ID field **410**, investment name field **415** and investment data pointer **420**. Investment ID field **410** stores a unique 32-bit value corresponding to a particular investment. Investment name field **415** stores a 16-byte character array of a name of an investment. Investment data pointer **420** stores a pointer to a linked list of financial data records related to an investment, which are stored in financial database **150***d* (described in more detail below).

FIG. **5***a* depicts the structure of an alert rule record that is stored in an alert rules database **150***c* at a financial information site **119** according to one embodiment of the present invention. According to one embodiment of the present invention, each alert rule specifies a percentile constraint of a resampled distribution for which a client **105** desires notification. Clients **105** of financial information site **119** may desire to be notified if the occurrence of a current event is extremely unlikely. As described in detail below, financial information site **119** executes a process to notify clients if a threshold percentile of a resampled statistical distribution is either below or above a current value of a financial event, indicating that the event is unlikely. For example, a client **105** may desire to be alerted if the gross rate of returns for a specified investment over a 200-day period assumes an improbable value. In this case, each day (or at a frequency specified by a client **105**), financial information site **119** calculates the actual gross rate of returns for the investment over the last 200 days. Then, financial information site **119** executes a resampled statistical process to evaluate the gross rate of returns for 200-day periods described in detail below) to determine whether a percentile value of the distribution is above or below the current value. If so, the current value is highly unlikely and the client **105** is notified via e-mail.

Each alert rule record **505** includes rule ID field **510** and rule function object* pointer field **515**. Rule ID field **510** stores a unique 32-bit integer value pertaining to an alert rule, which is used for identification purposes. Rule function object pointer field **515** stores a reference to a rule object (described with reference to FIG. **5***b*) relating to the occurrence of a financial event for which a client desires notification.

FIG. **5***b* depicts the structure of an alert rule object according to one embodiment of the present invention. Each rule alert rule record **507** includes investment ID field **520**, function field **525**, periods field **530**, operator field **535**, percentile value field **540**, sample size field **545** and replications field **550**. Investment ID field stores a 32-bit integer value identifying an investment, as described below with respect to FIG. **6***a*. Function field **525** stores a 32-bit function ID of a function record as described below with respect to FIG. **7**. Periods field **530** stores a number of periods (i.e., days) for which the client **105** desires to evaluate the investment. Operator field **535** stores a 4-bit field indicating an operator such as '<' or'>.' Percentile value field **540** stores an integer representing a percentile value. Sample size field **545** stores a 32-bit integer value representing a sample size for which to conduct a resampled statistical analysis. Replications field **550** stores a 32-bit integer value representing a number of replications to perform in conducting a resampled statistical process.

As described in detail below, the resampled process is conducted based upon parameters stored in fields **520**, **525**, **530**, **545** and **550**. Based upon operator filed **535**, it is then determined whether the distribution results for a resampled statistical process above or below the current value exceed the percentile value stored in percentile value field **540**. If so, the client is notified

FIG. **6***a* depicts a data structure for storing financial data in a financial database according to one embodiment of the present invention. Each financial data record **605** includes investment ID field **610**, and one or more return objects **625**(1)–**625**(N). Investment ID field **610** stores a 32-bit integer value uniquely identifying a financial record. Return objects **625** (as described in FIG. **6***b*) store actual data values of returns associated with the investment represented by investment ID field **610**.

FIG. **6***b* depicts a data structure for storing a return object according to one embodiment of the present invention. Each return object **625** includes a date field **630** and a value field **635**. Date field **630** stores a data object corresponding to the data of a return and value field **635** stores the value (dollar amount or otherwise) of the investment on the date stored in date field **630**.

FIG. **7** depicts a data structure for storing data in a function database **150***f* at a financial information site **119**

according to one embodiment of the present invention. Function database **150***f* stores various function prototypes for functions to be performed on investment data, which are used in performing resampled statistical analysis of financial data. For example, according to one embodiment function database **150***f* stores function prototypes for gross rate of return, maximum drawdown and/or a monitor function. Each function record **705** includes function prototype ID **710** and function prototype object **715**. Function prototype ID field **710** stores a unique 32-bit integer value pertaining to a function prototype, which is used for identification purposes. Function prototype object field **715** stores a 1024-byte character array of a function prototype. The syntax for representing a function prototype stored in function prototype object field **715** is variable. Practitioners skilled in the art will recognize that many data structures and techniques may be utilized to represent function prototypes. According to one embodiment of the present invention, a maximum drawdown function prototype is stored in function database **150** based upon the following equation: For a set of returns (r_1-r_n):

Max. Drawdown =

$$1 - \text{Min}\begin{pmatrix} \frac{1+r_1}{1} & \frac{(1+r_1)(1+r_2)}{1} & \frac{(1+r_1)(1+r_2)(1+r_3)}{1} & \cdots & \frac{(1+r_1)(1+r_2)(1+r_3)\ldots(1+r_n)}{1} \\ 0 & \frac{(1+r_1)(1+r_2)}{(1+r_1)} & \frac{(1+r_1)(1+r_2)(1+r_3)}{(1+r_1)} & \cdots & \frac{(1+r_1)(1+r_2)(1+r_3)\ldots(1+r_n)}{(1+r_1)} \\ 0 & 0 & \frac{(1+r_1)(1+r_2)(1+r_3)}{(1+r_1)(1+r_2)} & \cdots & \frac{(1+r_1)(1+r_2)(1+r_3)\ldots(1+r_n)}{(1+r_1)(1+r_2)} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ 0 & 0 & 0 & \cdots & \frac{(1+r_1)(1+r_2)(1+r_3)\ldots(1+r_n)}{(1+r_1)(1+r_2)(1+r_3)\ldots(1+r_{n-1})} \end{pmatrix}$$

According to one embodiment of the present invention, a gross rate of returns function prototype is stored in function database **150***f* based upon the follow equation: For a set of returns (r_1-rn):

$$\text{Gross Rate of Return} = \left[\prod_i (1+r_i)\right] - 1$$

According to one embodiment of the present invention, a monitor function calculates a number of 'up' or 'down' days for a given investment over a certain period. Thus, the following equation describes a monitor function:

$$\sum_i^N \delta(r_i = \text{up})$$

Thus, for example, according to one embodiment, the maximum drawdown function, the gross rate of return function (as described above) and the monitor function are coded according to a predefined syntax and stored as a function prototype in function database **150***f*.

FIG. **8** depicts a data structure for storing plot information in a plot database at a financial information site according to one embodiment of the present invention. Each plot type record **805** stores plot type ID field **810** and one or more plot parameter fields **825**(1)–**825**(N). Plot ID field stores a unique 32-bit integer identifying a particular plot type. Plot parameter fields **825**(1)–**825**(N) store various parameters relating to formatting of plots.

FIG. **9***a* (reprinted from Efron and Tibshirani) depicts the underlying theory of the bootstrap method. Ideally statistical inferences are based on a known probability distribution F. A parameter is a function of a known probability distribution F.

$$\theta = t(F)$$

Furthermore, generally financial data may not be modeled parametrically because it is heavy tailed (i.e., non-Gaussian) and therefore, F is not known or ascertainable. For example, with respect to financial data, an investor may desire to study a specific parameter of a financial investment such as the gross rate of return of a stock over a certain period of time that is dependent upon knowledge of the true probability distribution function for the investment. However, generally neither the PDF for an investment, nor the PDF for a parameter such as the gross rate of return over a specified time period for the investment (which is dependent upon the underlying PDF) is known.

Resampled statistical methods such as the bootstrap attempt to estimate the PDF of an unknown distribution using sampled data. Typically, sample data is available for an investment that is dependent upon an unknown PDF F.

$$F \rightarrow x = (x_1, x_2, \ldots x_n)$$

The empirical distribution function $\hat{F}$ is defined to be the discrete distribution that puts probability 1/n on each value x_i, i=1,2, . . . n. $\hat{F}$ assigns to a set A in the sample space of x its empirical probability $\text{Prob}\{A\}=\#\{x_i \in A\}/n$, In, the proportion of the observed sample $x=(x_1, x_2, \ldots, x_n)$.

The plug-in principle is a method of estimating parameters from samples. The plug-in estimate of a parameter $\theta=t(F)$ is defined to be $\hat{\theta}=t(\hat{F})$ **910**. These statistics are referred to as summary statistics, estimates or estimators. Resampled statistical methods attempt to determine the distribution of $\hat{\theta}$, an estimator of θ, derived from a sample x.

Bootstrap methods depend on the notion of a bootstrap sample. If $\hat{F}$ is an empirical distribution with probability of 1/n for each of the observed values x_i, i=1,2, . . . n, a bootstrap sample is defined to be a random sample of size n drawn from $\hat{F}$, $x^*=(x_1^*, x_2^*, \ldots, x_n^*)$, where $\hat{F} \rightarrow (x_1^*, x_2^*, \ldots, x_n^*)$. The star notion indicates that x^* is not the actual data set x, but rather a randomized, or resampled version of x. The bootstrap data points $x_1^*, x_2^*, \ldots, x_n^*$ are a random sample of size n drawn with replacement from the population of n objects $(x_1, x_2, \ldots, x_n)$. Corresponding to a bootstrap data set x^* is a bootstrap replication of $\hat{\theta}$, $\hat{\theta}^*=s(x^*)$ **915**. The quantity $s(x^*)$ is the result of applying the same function $s(\cdot)$ to x^* as was applied to x (i.e., the statistical function of interest). For example, $s(\cdot)$ may be the gross rate of return of an investment over a specific period of time.

Thus the bootstrap attempts to estimate a parameter of interest $\theta=t(F)$ from an unknown distribution F using a random sample $x=(x_1,x_2,\ldots,x_n)$. Given a random sample $x=(x_1,x_2,\ldots,x_n)$ and a statistic $\hat{\theta}=s(x,F)$ that depends on the sample and possibly the underlying distribution F, the distribution of $\hat{\theta}$,

$$\zeta_F(\hat{\theta}=s(x,F))$$

is estimated by that of

$$\zeta_{\hat{F}}(\hat{\theta}^*=s(x^*,\hat{F})$$

FIG. **9***b* depicts a process for performing a bootstrap method (a resampled statistical method) to generate a distribution of bootstrap replications according to one embodiment of the present invention. In step **920**, *a* sample space x is selected. In step **925**, *a* statistical function based on the sample space data is computed $\hat{\theta}=t(\hat{F})$. In step **930**, bootstrap samples $x^*=(x_1^*,x_2^*,\ldots,x_n^*)$, are generated from the sample space using a resampling process. In step **935**, *a* bootstrap replication $\hat{\theta}=s(x^*)$ is computed for each bootstrap sample using a desired function. In step **940**, a plot of the distribution of bootstrap replications $(s(x^{*1}),s(x^{*2}) \ldots s(x^{*B}))$ is generated in order to estimate the distribution of $\hat{\theta}$.

FIG. **10** is a flowchart of steps for initializing a resampled statistical analysis of financial data at a financial information site **119** according to one embodiment of the present invention. In step **1005**, the process is initiated upon receipt of a request for a resampled statistical analysis of financial data, which is received via front end subsystem **129** (e.g., via an HTML form). In step **1010**, input parameters relating to a resampled statistical analysis are received via client/gateway server **140***a* and transmitted to back end server **140***b*. According to one embodiment, the following parameters are solicited from a client **105**: investment;

function;

periods (Q);

bias;

sample_size;

replications; and

plot_type.

The 'investment' parameter specifies an identifier of an investment (i.e., **410**) stored in investment database **150***e*. The 'function' parameter specifies a function prototype identifier (i.e., **710**) stored in function database **150***f*. For example, according to one embodiment, the function prototype may correspond to a function for maximum drawdown, gross rate of return or a monitor function as described above. The 'periods' parameter specifies a number of periods for which a client **105** desires to evaluate an investment. For example, a client **105** may desire to perform a resampled statistical analysis for the gross rate of returns of an investment over a 253-day period. The 'bias' parameter is a decimal value that is either −1 or between 0 and 1 that specifies the degree of randomness in the resampling process. A value of −1 indicates that the resampling process should be conducted purely randomly. As described in more detail below, if the 'bias' parameter is between 0 and 1, sampling is performed so that b% of the samples are 'up' days and 1−b% of the samples are 'down' 'days, where b=bias. Thus, if b=1, only 'up' days will be selected and if b=0 only 'down' days are selected. The 'sample_size' parameter specifies a number of samples to use in the resampling process (the size of the x). The 'replications' parameter specifies a number of bootstrap samples to be used in the resampling process. The 'plot_type' parameter specifies a plot type identifier (i.e., **810**) pertaining to formatting parameters to be used in generating a plot of distribution results.

In step **1015**, back end server **140***b* requests the initiation of a resampled statistical analysis process at RSAE **139**. In particular, according to one embodiment of the present invention, back end server **140***b* transmits the following vector to control server **140***c* at RSAE **139**:

request_resampling process (investment, function, periods (Q), bias, sample_size, replications, plot_type)

Back end server **140***b* then waits for completion of the resampled statistical analysis task. In step **1020**, back end server **140***b* determines whether RSAE **139** has completed the resampling process. According to one embodiment, upon completion of the resampling process, control server **140***c* transmits a completion signal to back end server **140***b* and an address in output data area **160***b* where output data of a resampled statistical process is stored. If the resampling process is not completed ('no' branch of step **1020**), back end server **140***b* continues to wait for notification. If the resampling method is completed ('yes' branch of step **1020**), in step **1025**, back end processor **140***b* requests a graphics plot from GRE **129**. In particular, according to one embodiment, back end processor **140***b* transmits the following vector to graphics rendering server **140***e* at GRE **149**:

plot(OutAddr, plot_type, plot_parameters).

OutAddr specifies an address in output data area, which stores results of a resampled statistical process previously conducted by RSAE **139**, plot_type specifies a plot type requested by a client **105** and plot_parameters specifies additional plotting parameters that may be required by GRE **129**. Back end server **140***b* then waits for completion of the plot. In step **1027**, back end processor **140***b* determines whether graphics rendering server **140***e* has completed the requested plot (i.e., whether graphics server has transmitted a completion signal to back end processor). According to one embodiment, upon completion of a plot, graphics rendering server **140***e* transmits a completion signal to back end processor **140***b*. Graphics rendering server **140***e* also transmits results of the plotting process in the form of plot data, which may be used to dynamically create an HTML page for transmission to a client **105**. If the plot is not finished ('no' branch of step **1027**), back end processor **140***b* continues to wait for the completion signal. If the plot has been completed ('yes' branch of step **1027**) in step **1029** and back end processor **140***b* transmits the plot data results (e.g., HTML page) to client/gateway server **140***a* for transmission to client **105**. The process ends in step **1030**.

FIG. **11** is a flowchart that depicts a set of preparation steps performed by a control server **140***c* at a financial information site **119** to initialize a resampled statistical analysis of financial data using a parallel processing. In step **1105**, the process is initiated upon the receipt of a request_resampling_process vector from back end server **140***b* as described above with reference to FIG. **10**.

In steps **1115**–**1119**, control server **140***c* reserves appropriate memory in shared memory area **160***a* and output data area **160***b* and stores appropriate sample data for processing in shared memory area **160***a*. In particular, in step **1115**, *a* sample space is determined using the sample_size parameter received in step **1105**. Because financial database **150***d* may store samples for investments for many different time periods, in step **1115**, *a* set of relevant samples for the resampled statistical analysis requested by the client **105** is determined. In step **1117**, based upon the sample_size parameter, control server **140***c* determines an amount of

memory required for storage of samples in shared memory area **160***a* and allocates an appropriate memory block in shared memory area **160***a* for storage of the samples. Further, based upon the replications parameter, server **140***c* also determines an amount of memory to reserve in output data memory area **160***b* for storage of results of the resampling process. In step **1119**, based upon the sample_size parameter, server **140***c* retrieves financial data samples from financial database **150***d* and stores these samples in shared memory area **160***a* in the memory block previously reserved in step **1117**. In step **1120**, process server **140***c* computes $\hat{\theta}$ from the sample data stored in shared memory area **160***a*. In particular, a statistical function such as the mean, median or standard distribution is calculated by dividing the sample space into appropriate length periods.

In steps **1125–1160**, control server **140***c* executes a series of steps to format and prepare the data for processing. Specifically, in step **1125**, autocorrelation of the sample space data stored in shared memory area **160***a* is analyzed. Specifically, control server **140***c* executes a process to calculate the autocorrelation and partial autocorrelation functions on the data stored in shared memory area **160***a* for a number of different lag periods (a) and stores the results in temporary storage. According to one embodiment, the following equations are utilized to calculate the autocorrelation and partial autocorrelation functions for the data stored in shared memory area **160***a*:

$\forall a<n$ and $1 \leqq x<a$:

Samples in the sample space are defined as:

$r=(r_1, r_2, \ldots, r_n)$

Shifted versions of the sample space are defined:

$Z_1 \equiv (r_1, r_2, \ldots, r_{n-a})$

$Z_2 \equiv (r_{a+1}, r_2, \ldots, r_n)$

$Z_x \equiv (r_{a+1-x}, \ldots, r_{n-x})$

The autocorrelation function is defined as:

$$ACF(a) = \frac{S(a)_{Z_1 Z_2}}{S(a)_{Z_1} S(a)_{Z_2}}$$

The partial autocorrelation function is defined as:

$$PACF(x, a) = \frac{S(a)_{Z_1 Z_2} - S(a)_{Z_2 Z_x} S(a)_{Z_1 Z_x}}{\sqrt{1 - (S(a)_{Z_2 Z_x})^2}\sqrt{1 - (S(a)_{Z_1 Z_x})^2}}$$

The following are intermediate calculations:

$$S(a)_{Z_1 Z_2} = \frac{(Z_{1_i} - \overline{Z_1})(Z_{2_i} - \overline{Z_2})}{n - a - 1}$$

$$S(a)_{Z_1} = \sqrt{\frac{\sum_{i=1}^{n-a} (Z_{1_i} - \overline{Z_1})^2}{n - a - 1}}$$

$$S(a)_{Z_2} = \sqrt{\frac{\sum_{i=a+1}^{n} (Z_{2_i} - \overline{Z_2})^2}{n - a - 1}}$$

$$\overline{Z_{1_i}} = \sum_{i=1}^{n-a} \frac{Z_{2_i}}{n - a}$$

$$\overline{Z_{2_i}} = \sum_{i=a+1}^{n} \frac{Z_{2_i}}{n - a}$$

In step **1130**, the autocorrelation and partial autocorrelation data calculated is analyzed to determine a minimum lag factor (N) that minimizes the autocorrelation (a). The minimum lag factor (a) corresponds to the number of consecutive periods that are selected at one time during the resampling process.

In step **1135**, the bias parameter received in step **1105** is analyzed. If no bias is selected (i.e., bias=−1 and data is to be selected randomly), control passes to step **1045** ('no' branch of step **1035**). If bias<>0, in step **1040**, a bias initialization algorithm is performed as described in detail below. In step **1145**, it is determined whether the sample space data should be transformed. This determination is based upon the precise function requested by the client **105** (i.e., specified by function parameter). For example, if the function is gross rate of return over a specified period, no transformation step is required. However, if for example, the function type is the monitor type, the sample data is transformed to represent the sign of the returns only (i.e., −1 and +1). Other variations will exist depending upon the type of functions implemented. If no transformation is necessary ('no' branch of step **1145**), control is transferred to step **1160**. Otherwise ('yes' branch of step **1045**) in step **1150**, the data is transformed and restored in shared memory area **160***b* in step **1150**.

In step **1160**, the variable M=Int(Q/N) is determined. The variable 'M' specifies the number of samples to select for each resampling. In step **1165**, server **140***c* executes a request for parallel processing of data stored in shared memory area **160***a* by transmitting a vector to parallel processing control server **140***d* using the prototype: Request_Parallel_Process(input_addr, input_range, output_addr, output_range, M, N function, bias, replications). The parameters 'input_addr', 'input_range', 'output_addr' and 'output_range' correspond respectively to the start address and range in shared memory area **160***a* and output memory area **160***b* that were determined in step **1117**. The parameters M and N correspond to the variables determined in steps **1130** and **1160** respectively. The parameters 'bias' and 'replications' correspond to the same parameters received in step **1105**.

In step **1170**, control server **140***c* determines whether it has received a signal from parallel process control server **140***d* indicating the completion of parallel processing. If not ('no' branch of step **1070**), control server **140***c* continues to wait for the completion signal. If a completion signal has been received ('yes' branch of step **1170**), in step **1175**, control server **140***c* transmits a completion signal to back end server **140***b* along with a memory address in output data area **160***b* where the output data for the resampled method is stored.

FIG. **12** is a flowchart of a parallel processing control process according to one embodiment of the present invention. Although only 5 parallel processors (**112***a*–**112***e*) are depicted in FIG. **1**, this number is arbitrary and any number P of parallel processors may be used to perform the resampling technique. Furthermore, although the method described herein utilizes a parallel processing architecture, the present invention does not require a parallel processing scheme. According to one embodiment of the present invention, the process depicted in FIG. **12** is implemented by parallel process control server **140***d* at financial information site **119**.

In step **1205**, parallel process control server **140***d* receives a vector requesting a parallel process as described in step **1165**. In step **1210**, parallel process control server **140***d* performs a load balancing step. In step **1220**, parallel process control server **140***d* requests the initiation of processes on individual parallel processors **112***a*–**112***e* by trans-

mitting a begin_process vector to each respective parallel processor **112***a*–**112***e*. According to one embodiment of the present invention the vector is transmitted to each processor **112***a*–**112***e* to initiate parallel processing: begin_process (input_addr, input_range, M, N, function, bias, replications/P). The parameters 'input_addr', 'input_range', correspond respectively to the start address and range in shared memory area **160***a* that were received in step **1205**. The parameters 'periods', 'bias'and 'replications', 'M' and 'N' correspond to the same parameters received in step **1205**. P specifies the number of parallel processors. Thus, each parallel processor computes replications/P replications.

In step **1230**, parallel process control server **140***d* checks to determine whether all parallel processors **112***a*–**112***e* have completed processing. Upon completion of a processing task, each parallel processor executes a step of notifying control server **140***c* of completion. In particular, according to one embodiment, upon completion each parallel processor **112** sends parallel process control server a notification message defining a memory block where output results have been stored on the respective local cache **112***a***1**–**112***e***1**. If notifications have not been received from all processors **112***a*–**112***e*, parallel process control server **140***c* continues waiting ('no' branch of step **1120**). Upon receipt of all completion notifications ('yes' branch of step **1230**), parallel process control server **140***d* retrieves the data output for each parallel processor stored on local cache **112***a***1**–**112***a***5**.

In step **1240**, parallel process control server assembles all output data from each respective local cache **112***a***1**–**112***e***1** in output data area **160***b*. In step **1250**, parallel process control server **140***d* notifies server control **140***c* that the parallel processing is completed. The process ends in step **1260**.

FIG. **13** is a flowchart of set of steps for performing a resampled statistical method according to one embodiment of the present invention. The steps shown in FIG. **13** are executed on each parallel processor **112***a*–**112***e* upon the request for a parallel process by server **140***d*. In step **1305**, the process is initiated and each parallel processor receives a begin_process vector as described above with reference to step **1220** of FIG. **12**. In step **1310** each respective processor **112***a*–**112***e* determines a range of output memory in local cache **112***a***1**–**112***e***1** for storage of output results. In step **1320**, the parallel processor **112** determines a random start location in shared memory area **160***a* to begin sampling. In step **1325**, it is determined whether all replications (Q) have been completed. If not ('no' branch of step **1325**) processing continues with steps **1330**–**1345**. Steps **1330**–**1345** correspond to the selection of a bootstrap sample $x^{*Replication}$. In step **1330**, a temporary variable 'Count' is set to zero. In step **1335**, N consecutive periods of sample points are selected from shared memory area. The degree of randomness in selection is determined by the variable 'bias'. If bias=−1, the beginning of each consecutive period is selected purely randomly. If the 'bias' parameter is set to any value other than −1, sampling is performed so that bias percent of the samples are "up" days for the investment and 1-bias percent of the samples are "down" days for the investment as described in detail below. Thus, if bias=1, only "up" days will be selected. In step **1340**, the temporary 'Count' variable is increment. A biasing process is described in detail below with reference to FIG. **14**. In step **1345**, it is determined whether Count=M. If not ('no' branch of step **1345**), flow continues with step **1335** (i.e., another N consecutive periods are selected). If so ('yes' branch of step **1345**), flow continues with step **1350**, and a bootstrap replication $s(x^{*eplication})$ is computed corresponding to the function s(.) received in step **1305**. In step **1355**, the bootstrap replication $s(x^{*replication})$ is stored in local cache (e.g., **120***a***1**). Flow continues with step **1325**. When all replications have been completed ('yes' branch of step **1325**), in step **1360**, the parallel processor **112** notifies parallel process control server **140***d* that processing has been completed and also notifies parallel process control server **140***d* of the memory block in local cache (i.e., **112***a*–**112***e***1**) where the output data is stored.

FIG. **14** is a flowchart of a set of steps for conducting a bias algorithm according to one embodiment of the present invention. The process is initiated in step **1405**. In step **1410**, the sample space is separated into two sets, a first set including only 'up' days and a second set including only 'down' days. In step, **1420** *a* random number r, between 0 and 1 is selected. In step **1430**, it is determined whether the random number r<=b (the bias parameter specified by the client). If so ('yes' branch of step **1430**), in step **1440**, an up day is selected. If nor ('no' branch of step **1440**), in step **1450**, *a* down day is selected. The process ends in step **1460**. The process depicted in FIG. **14** is repeated for each bootstrap sample.

FIG. **15** is an exemplary plot of a resampled statistical analysis comparing two investment strategies with respect to gross rate of returns. As depicted in FIG. **15**, investment strategy **1510** outperforms investment strategy **1520**.

FIG. **16** is an exemplary plot of a resampled statistical analysis comparing two investment strategies with respect to maximum drawdown. As depicted in FIG. **16**, investment strategy **1610** outperforms investment strategy **1620**.

FIG. **17** is an exemplary plot of a resampled statistical analysis comparing two investment strategies with respect to a monitor function. As depicted in FIG. **17**, investment strategies **1720** outperforms investment strategy **1710**.

What is claimed is:

1. A method for calculating, analyzing and displaying investment data comprising the steps of:

(a) selecting a sample space, wherein the sample space includes at least one investment data sample;

(b) generating a distribution function using a re-sampled statistical method and a bias parameter, wherein the bias parameter determines a degree of randomness in a resampling process; and,

(c) generating a plot of the distribution function.

2. The method according to claim **1**, wherein the re-sampled statistical method is a bootstrap method.

3. The method according to claim **2**, wherein step (b) includes the steps of:

(a) generating at least one bootstrap sample from the sample space; and,

(b) for each bootstrap sample, generating a corresponding bootstrap replication.

4. The method according to claim **3**, wherein the step of generating at least one bootstrap sample, further includes the steps of randomly selecting a set of Q data points from the sample space, wherein Q is a number of periods.

5. The method according to claim **4**, wherein the step of generating a bootstrap replication, further includes the step of taking a predetermined function of a bootstrap sample.

6. The method according to claim **3**, further including the steps of:

(a) before step (b), calculating at least one of an autocorrelation function and a partial autocorrelation function of the sample, space for each of at least one lag parameter (a); and,

(b) determining a minimum lag parameter, N, wherein the minimum lag parameter N minimizes an autocorrelation function of the sample space.

7. The method according to claim 6, wherein the step of generating at least one bootstrap sample, further includes the steps of:

(a) randomly selecting a starting point in the sample space;

(b) selecting a set of N consecutive data points from the sample space; and,

(c) repeating steps (a)–(b) until at least Q data points have been selected, wherein Q is a number of periods.

8. The method according to claim 1, wherein the re-sampled statistical method is a jackknife method.

9. The method according to claim 1, where in the re-sampled statistical method is a cross-validation method.

10. The method according to claim 5, wherein the predetermined function is one of a gross rate of return function, a maximum drawdown function and a monitor function.

11. A method for providing statistical analysis of investment data over an information network, comprising the steps of:

(a) storing investment data pertaining to at least one investment;

(b) receiving a statistical analysis request corresponding to a selected investment;

(c) receiving a bias parameter, wherein the bias parameter determines a degree of randomness in a resampling process; and,

(d based upon investment data pertaining to the selected investment, performing a resampled statistical analysis to generate a resampled distribution.

12. The method according to claim 11, further including the steps of generating a plot based upon the resampled distribution.

13. The method according to claim 12, wherein the statistical analysis request includes at least one of an investment identifier, a periods parameter, a function parameter, a replications parameter and a plot parameter.

14. The method according to claim 12, wherein the step of performing a resampled statistical analysis further includes the steps of:

(a) selecting a sample space;

(b) generating at least one bootstrap sample from the sample space; and,

(c) for each bootstrap sample, generating a corresponding bootstrap replication.

15. The method according to claim 14, wherein the step of generating at least one bootstrap sample, further includes the steps of randomly selecting a set of Q data points from the sample space, wherein Q is a number of periods.

16. The method according to claim 14, wherein the step of generating a bootstrap replication, further includes the step of taking a predetermined function of the bootstrap sample.

17. The method according to claim 14, further including the steps of:

(a) before step (b), calculating at least one of an autocorrelation function and a partial autocorrelation function of the sample space for each of at least one lag parameter (a); and

(b) determining a minimum lag parameter, N, wherein the minimum lag parameter N minimizes an autocorrelation function of the sample space.

18. The method according to claim 17, wherein the step of generating at least one bootstrap sample, further includes the steps of:

(a) randomly selecting a starting point in the sample space;

(b) selecting a set of N consecutive data points from the sample space; and,

(c) repeating steps (a)–(b) until at least Q data points have been selected, wherein Q is a number of periods.

19. The method according to claim 15, wherein the bias parameter is used to control a degree of randomness in selecting the set of Q data points.

20. The method according to claim 11, wherein the information network is the Internet.

21. The method according to claim 16, wherein the predetermined function is one of a gross rate of returns function, a maximum drawdown function and a monitor function.

22. A system for providing statistical analysis of investment information over an information network comprising:

a financial data database for storing investment data;

a client database;

a plurality of processors collectively arranged to perform a parallel processing computation, wherein the plurality of processors is adapted to:

receive a statistical analysis request corresponding to a selected investment;

based upon investment data pertaining to the selected investment, perform a resampled statistical analysis to generate a resampled distribution; and,

provide a report of the resampled distribution.

23. The system according to claim 22, wherein the report of the resampled distribution is a distribution plot.

24. The system according to claim 22, wherein the statistical analysis request includes at least one of an investment identifier, a bias parameter, a periods parameter and a plot parameter.

25. The system according to claim 22, wherein the processor:

(a) selects a sample space;

(b) generates at least one bootstrap sample from the sample space; and,

(c) for each bootstrap sample, generates a corresponding bootstrap replication.

26. The system according to claim 22, further including an alert rules database, wherein the alert rules database stores at one alert rule record pertaining to a condition upon which a client desires to be notified.

27. The system according to claim 26, wherein the processor, upon the violation of an alert rule based upon a resampled statistical analysis, notifies a client.

28. The system according to claim 27, wherein the client is notified by electronic mail ("e-mail").

29. A system for providing statistical analysis of investment information over an information network comprising:

a financial data database for storing investment data;

a front end subsystem for receiving a statistical analysis request;

a parallel processor, wherein the parallel processor includes:

at least one processor for performing resampled statistical analysis.

30. The system according to claim 29, wherein the front end subsystem includes a Web server.

31. The system according to claim 29, wherein each of the at last one processor performs a resampled statistical analysis of a financial investment in parallel using financial data stored in a shared memory area.

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